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NATIONAL FIRE PROTECTION ASSOCIATION

"To Promote the Science and Improve the Methods of Fire Protection and Prevention."

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Accounts of fires appearing in the Quarterly are copies of or extracts from reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

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Press Association.

The burning of this hangar at the Wichita, Kansas, municipal airport, Sept. 26, 1945, caused a loss of $75,000 to the 28,000 sq. ft. hangar building. Twenty-eight planes were destroyed, with a probable loss of over $200,000. Automatic sprinklers had been recommended, but as the city is on a "pay as you go" basis, funds had been sufficient only for a reservoir. The sprinkler system was to have been installed later. Discovered in a fabric-covered plane wing at 11:15 p.m. when the hangar was closed, the fire was fought unsuccessfully by employees for some minutes before the city fire department was called.

The Quarterly

Vol. 39 October, 1915 No. 2

"Year Book" The 1945 Year Book and N.F.P.A. membership directory is published as Part II of this QUARTERLY. With the listing of more than 10,000 members, some 60 committees dealing with all phases of fire prevention and fire protection, and other information on the far-reaching activities of the Association, the compilation and publication of this volume has been a major undertaking. We have endeavored to produce an accurate record of the names, addresses and activities of all our members, but in compiling a record as extensive as this some errors may occur despite every precaution.

* * *

Hospital and Institution Fires Published as Part III of this QUARTERLY is a summary of hospital and institution fires compiled from N.F.P.A. fire records, bringing up to date the previous compilation in the QUARTERLY ten years ago. This record, while distributed as a part of the QUARTERLY, is bound separately with the thought that in this way it may be more useful to members who desire to use this information as a basis for securing fire protection improvements in hospitals and institutions in which they are interested. Additional copies are available for such use. We hope now that wartime restrictions have been lifted, N.F.P.A. members throughout the United States and Canada will concern themselves with securing needed fire protection improvements in old hospitals and institutions which present a fire menace, and will exert their influence towards fire-safe construction where new buildings are erected.

* * *

Large Loss Sprinklered Fires During the past year there have been an unusual number of large loss fires in sprinklered buildings. This is a cause of considerable concern to N.F.P.A. members who for years have looked upon automatic sprinkler protection as a remedy for most deficiencies in fire safety and have become accustomed to thinking of the automatic sprinkler as providing nearly 100% protection against disastrous fire. During recent years there has been a tendency to erect manufacturing and storage buildings of combustible construction, often with highly combustible contents, covering single undivided fire areas which would have been unthought of in earlier years. Automatic sprinkler systems have been largely relied upon to provide protection in such cases. When for any reason the protection fails, the losses are apt to be very large. An analysis of reports of recent large loss sprinklered fires received by the N.F.P.A. Executive Office indicates that in addition to failures due to closed valves there have been many cases where the loss is directly or indirectly chargeable to failure to provide a complete sprinkler system in accordance with N.F.P.A. standards. Sprin-

kler systems are primarily designed to control fires in their incipiency. Experience shows that where a fire starts and reaches large proportions in an unsprinklered area, it often spreads and overwhelms the sprinklers in the main sections of the building which are protected. The same thing can happen in the case of extensive concealed spaces lacking fire stopping.

Recent fire experience points strongly towards the fundamental importance of the provisions of the N.F.P.A. Sprinkler Standards which call for complete protection in all areas, including attics and combustible spaces under floors. The record shows that it is mistaken economy to omit sprinkler heads from such spaces as is unfortunately done in many instances where installation in attics or spaces under floors would involve some extra trouble and expense and it is mistakenly believed that there is nothing in such spaces to start or spread fire. While it is true that even partial sprinkler protection has very real value, it is a mistake to rely upon complete protection from sprinklers unless they are installed completely throughout all portions of the premises as specified by N.F.P.A. standards.

* * *

The Great Destroyer

THE WASHINGTON POST on September 17, 1945, carried an editorial entitled "The Great Destroyer," which we are reprinting below as an outstanding example of an enlightened and understanding discussion of the fundamentals of fire protection.

Reports from Miami state that fires, whipped by winds of hurricane force, have engulfed three hangars at the Richmond Navy blimp base, destroying several hundred planes, killing one man and injuring a good many others. The doomed structures are said to have been the largest single-arch wooden hangars in the world. That bit of information causes one to ask whether smaller, less flammable structures dispersed over a wider area would not have served the Navy's purpose sufficiently well, while greatly reducing the fire hazard.

We learned to our cost at Pearl Harbor that it does not pay to put too many eggs in one basket. That holds true not only in time of war when acts of sabotage are especially to be feared. It is true at all times, because fire, that great destroyer of life and property, is an ever-present menace. The Government now holds immense amounts of surplus property in storage in all parts of the country as well as abroad. While the war was in progress vigilance in guarding stored supplies and properties essential to production of war materials appears to have kept fire losses at a comparatively low level. At least the increase in losses from fire is not large in view of the huge increase in property on hand and the existence of an emergency admitting of no delay in providing storage facilities.

However, now that the war is over, consideration should be given to plans for reducing future fire losses. To many people protection against fire means primarily construction of fireproof buildings, patrolling of premises by watchmen, installation of apparatus for extinguishing fires and construction of fire escapes or exits. But such precautions, important though they are, afford only partial protection and not always that. Fires resulting from carelessness or from natural causes, such as the hurricane now ravaging Florida, may get out of control despite fireproofing and sprinklers, especially if great masses of goods are stored under one roof or located in congested areas. It is, therefore, most important to plan structures and dispose of materials in such fashion as to minimize the possibilities of loss if fires break out.

Unfortunately, the information on fire losses reported by the Federal Fire Council is admittedly incomplete as to coverage. It also fails to state how losses were apportioned among the various Federal departments and agencies. With total reported fire losses for the year amounting to nearly 39 million dollars, the property damage from the 348 fires whose causes were unknown reached 23 million dollars. From this record we conclude that the Government should take steps to improve its investigation of fires, as the council suggests.

It should also develop protective devices in conformity with the most progressive standards adopted by large private concerns. For instance, the Fire Council recommends that Federal agencies review plans for new postwar construction, with special consideration of the type and location of structures, separation of occupancies and safeguarding of heating systems. Certainly huge warehouses with acres of floor space would present a hopeless challenge to firefighters if a blaze were to get a good start.

In our opinion, the Government needs an agency employing full-time experts in fire-protection procedure — an agency empowered not merely to give advice to other Government agencies, but also to enforce standards of safety of a preventive and protective nature. We are in a position to profit by the mistakes made while the war was in progress. We may have cause for bitter regret some day if the Government does not act promptly to secure the sort of all-around protection that the trained fire-protection engineer is equipped to give.

This editorial reflects an understanding of the importance of subdividing combustible property to minimize the possible damage in any one fire, which is unusual among editors and unfortunately foreign to the thinking of the general public. We subscribe wholeheartedly to most of the observations of this editorial writer in the WASHINGTON POST.

We are less certain, however, that another government agency would assure proper application for fire safety safeguards. For one thing, fire protection engineering talent of unusual competence would be required and we do not see evidence that this is yet recognized. To be effective, the agency would have to operate at the highest administrative level, and its recommendations would have to override the decisions of cabinet officials. Unless this principle is accepted (and we doubt if it would be), it would be just another tax-eating agency unable to do more than existing public and private agencies can do without top side administrative support.

We feel that the only answer is greater emphasis upon public education in the fundamentals of fire protection and that the most effective progress in improved fire safety will be made not by government edict, but through general understanding and appropriate action on the part of all concerned.

* * *

1944 Fire Loss Estimates

Intelligent fire prevention efforts are in a large measure dependent upon knowledge as to what are the chief causes of fire and in what classes of property fires are occurring. Accordingly, the N.F.P.A. Department of Fire Record presents the tables in this issue of the QUARTERLY, showing the distribution of the annual fire loss in the United States by cause and occupancy classifications.

It is interesting to note that despite the considerable increase in national fire losses, particularly in governmental and manufacturing occupancies, there was a marked decrease in the number of dwelling fires, as compared with the 1943 estimate. The 1944 tables show 285,000 dwelling fires, as compared with 330,000 the year before. This reduction in fires follows the experience of city fire departments which reported a 12 per cent reduction in building fires during 1944 (see April, 1945, QUARTERLY, page 274), as compared with 1943. It is believed that such factors as difficulty in obtaining building materials to replace fire damage, thus stimulating interest in fire prevention, shortage of housing, scarcity of fuel tending to prevent overheating (there was a marked decrease of fires attributed to defective and overheated flues), and economic factors making it difficult to burn for profit may partially account for this improved record.

Providence Journal.

The Fall River rubber fire on Oct. 11, 1941, in which 10,000 tons of crude rubber burned. Before this, N.F.P.A. members had warned of the danger of storing such large quantities of a critical material in a single fire area, but the government was apparently concerned only with the prevention of sabotage. Subsequently, due to the influence of N.F.P.A. members, crude rubber storage was subdivided and protected so that no further major losses occurred during the war period.

N.F.P.A. War Activities.

It would take many volumes to record the war activities of the thousands of members of the Association. This brief report is intended to cover merely the war program and activities of the Association itself and its staff.

The approach of our Association to its responsibilities and procedures in wartime can perhaps be well expressed by and was forecast by an editorial entitled "Fire and War," appearing in the July, 1940, *Quarterly*, from which we quote the following:

> In time of war or intensive preparation for national defense, fire protection is of great importance. When industries producing war materials are operating at top speed, there is every opportunity for fire, owing to the neglect of usual precautions under the stress of emergency conditions. Proper fire prevention precautions, adequate extinguishing equipment, and above all, proper organization to deal with fire matters, are all of utmost importance in any national war or defense program.
>
> The present situation calls for an effective and coordinated national program for fire safety. In a totalitarian state, such matters would be the sole responsibility of the central government, but in a democracy all concerned have opportunity to participate. It may be taken for granted that in the United States everyone concerned will cooperate. Voluntary service will be available without question from insurance men of various groups, fire chiefs, building inspectors and other public officials, manufacturers-of-equipment industries concerned, and patriotic citizens generally. We have the technical knowledge as to methods which should be applied to prevent disastrous fires. What is needed is coordination to minimize the overlapping of effort and duplication of work and eliminate the competition and petty jealousies which often occur between people working for a common end.

From the outset the officers and members of the Association created and supported a policy of all-out cooperation of the Association toward the winning of the war. At the meeting of the Board of Directors in January, 1941, almost a year before the outbreak of war, the Executive Office was authorized in the name of the Association to concentrate its attention upon the problems involved in national defense and possible war and "to secure all available information on the subject, to direct all available facilities toward the effective coordination of fire defense activities, calling upon members for such cooperation and assistance as may be needed, to proceed with measures for advancing fire defense as opportunities for service may appear."

During the period of national defense effort prior to the outbreak of war and throughout the war period, these policies as set forth by the Association's Directors have been consistently followed. The plan of operation in general essence was to maintain the usual work and services of the Association so far as possible, to increase materially the published literature and information to members and others on all aspects of fire control with relation to the war, to make contact directly with all governmental agencies and to offer freely the services of the Association and its staff to such agencies in connection with war problems of fire control. The only major change in previous procedure of the Association was the suspension of the field engineering service program which had been

International.

When the "Normandie" burned in New York harbor on Feb. 9, 1942, we lost the use of a transport that might have carried a million men overseas. This fire was charged to a spark from an acetylene torch, but the real cause was authority confused and divided among the Army, Navy and various civilian agencies, with no one agency clearly responsible for fire safety. The Navy subsequently developed a well-integrated fire protection program in which many N.F.P.A. members participated.

established in 1924 and consistently carried on up to the war period and to divert the staff members carrying on such work into direct war activities.

Throughout 1940 and 1941 most of the staff activities of the Association were focused on the development of additional information of value to industries producing war supplies, and participation in the beginnings of the civilian defense program of the country. All N.F.P.A. memberships from Axis countries were suspended in June, 1941, as it was felt that the information then being published by the Association should not reach unfriendly hands.

Perhaps the most important early contribution made by the Association was the publication of the comprehensive book, "Fire Defense," in March, 1941. This book largely set the pattern for fire defense as an important part of the whole civilian defense program and was widely utilized in the early days of the Office of Civilian Defense, the state defense councils, and in the civilian defense activities of our War Department and of the Canadian Government. Our staff helped to organize and participated in the first civilian defense school conducted by the Chemical Warfare Service of the War Department at Edgewood Arsenal in July, 1941. We were also instrumental in bringing about the organization of the Fire Defense Advisory Committee of the United States Office of Civilian Defense in the fall of 1941. Mr. Bugbee and Mr. Bond of the staff, among the early consultants to the United States Office of Civilian Defense, were appointed shortly after the creation of that office and remained in a consulting capacity to the OCD throughout its existence.

During this prewar period we obtained information on the German use of the incendiary bomb and the techniques of the German fire attacks upon England and perhaps the first concrete account of this procedure in this country was the article on the Incendiary Bomb, published in the October, 1940, *Quarterly*.

With these various activities under way, the transition into the active war period was made without any noticeable upheaval. A policy of still further increasing the output of literature that might be of service to war industries and war agencies was followed and a program instituted of staff contact with all agencies of the government that appeared to have any interest in or responsibility for fire protection. During this early period of the war, contacts were made with the Fire Prevention Division in the Office of the Under Secretary of War, with the Provost Marshal General's Office, the Chemical Warfare Service, the Ordnance Department, the Chief of Engineers' Office, and with other divisions of the Army Service Forces. Contacts also were developed with the Bureau of Yards and Docks and Bureau of Ships of the Navy Department, and with the United States Coast Guard. Members of the staff contacted the various divisions of the War Production Board concerned with fire protection matters and with the appropriate officials of the new National Housing Agency and the Federal Public Housing Authority. Our contacts and work with the Office of Civilian Defense increased, and contacts were made with the Office of Scientific Research and Development and the National Defense Research Committee. Throughout the war, members of the staff maintained close contact with the National Bureau for Industrial Protection, the organization set up by the various insurance organizations of the country in the interest of making insurance talent and information available to war agencies.

Ruins of the administration building of a large aircraft plant outside Chicago after a $1,500,000 fire on July 18, 1943. A devastating fire at this property had been predicted six months previously by N.F.P.A. Director Anthony Mullaney, Chief of the Chicago Fire Dept. and N.F.P.A. General Manager Bugbee. Fire department members of the N.F.P.A. did excellent work during the war period in warning of hazardous conditions and in extinguishing fires, but when not called until a fire in a large quick-burning building was well under way, all that any department could do was to save exposed property.

As various fire protection organizations began to develop through government agencies, many N.F.P.A. members assumed positions of responsibility, and in the fall of 1942 all of these members in Washington were gathered together at a dinner conference so that they could become acquainted with each other and their problems. As the complexity of the war organization increased, the amount of time and effort necessary to maintain contacts increased materially, and more and more time of the staff was devoted to work in Washington. At about this time it was decided to turn over the services of our Chief Engineer, Mr. Bond, 100 per cent to direct war activity of various kinds and for three years all of his time and effort have gone into strictly war work. Early in 1943, Mr. Bond was asked to go to England, ostensibly to study civilian defense methods in England for the benefit of our U. S. Office of Civilian Defense. While he did this work, his main object was to study the technique of incendiary bombing and to help lay plans for British and American incendiary techniques. Upon his return to this country, Mr. Bond set about a campaign of persistent education of various organizations and individuals concerned with fire warfare in the principles of effective fire technique. Many of the important decisions with respect to the type of incendiary, target analysis and other procedures of vital importance to the successful prosecution of the war were inspired by Mr. Bond's patient and persistent activities in this direction. The general procedure followed was outlined in the article in the July, 1945, *Quarterly,* by our staff member, Mr. McElroy, and further information of interest to members of the Association will be issued in due course. It is, of course, logical that the knowledge of fire protection engineers was necessary in developing techniques of fire warfare, and the information at the hands of our staff and of many members was freely made available to the appropriate agencies of the War and Navy Departments and the Office of Scientific Research and Development. During the closing period of the war, Mr. Bond has been in charge of fire damage studies for the Physical Damage Division of the United States Strategic Bombing Survey for the Secretary of War and spent four months in England and Germany on this special assignment.

From the outset of the war it became apparent that the War Production Board would play a major part in the establishment of fire protection because of its control over materials and supplies. Our Technical Secretary, Mr. Moulton, was appointed fire consultant to the War Production Board in November, 1942, and we maintained close contact with various branches of the War Production Board throughout the war. We expressed violent opposition to the early policies of the War Production Board with respect to priorities for fire protection equipment and persistently advocated a change in policy which finally developed during 1943. The discouraging of fire protection which was so evident in the early days of the war because of War Production Board and War Department policies was in our opinion an important factor in the series of large loss fires in war establishments. The publication of information throughout the war on all important fires affecting war industries, and the distribution of this information to all government contacts and important industrial leaders was influential in gradually changing the policy for the better.

Throughout the war the services of the staff were freely available to various

The burning of an Army warehouse in Oakland, Calif., on Nov. 8, 1943. Typical of numerous fires in military properties, the cause of the fire, the exact size and construction of the building, the type of fire protection (if any), the reason for delay in calling the fire department, the character of the contents and the amount of loss all remain shrouded in military secrecy. N.F.P.A. members could not understand why it was necessary in so many cases to maintain secrecy on the details of fires which might have provided valuable fire prevention lessons.

branches of the War and Navy Departments and the Coast Guard. In the fall of 1942 the Provost Marshal General of the United States created an Advisory Council on Fire Protection which consisted of Mr. Bugbee, Chairman, and members C. W. Pierce and H. L. Miner. This Council consistently fought to simplify the complicated and confused procedures on fire protection that had developed in the War Department. In January, 1944, the Under Secretary of War created a five-man Advisory Board on Fire Protection on which Mr. Bugbee served as the civilian member. This board continued throughout the war period. Through these official connections and otherwise, close contact was maintained with the War Department activities on fire protection in every branch. Cordial relations were maintained with Commander Harold K. Hughes in charge of fire protection for the Bureau of Yards and Docks of the Navy, with Commander Harold J. Burke in charge of the fire training program of the Navy for the Bureau of Ships, and with Admiral Russell K. Waesche, commandant of the United States Coast Guard. The work carried out by these various organizations has been described in N.F.P.A. publications in some detail.

Perhaps more N.F.P.A. members had contact with aspects of the civilian defense program than any other in connection with the war activities. The Fire Defense Advisory Committee of the U. S. Office of Civilian Defense, previously referred to, continued during the early part of the war and a good deal of time was devoted to its work. In February, 1942, the U. S. Office of Civilian Defense created an Industrial Advisory Committee of which Mr. Bugbee was made chairman, and this committee prepared the manual on Passive Plant Protection which was published by the OCD and sent to all industrial establishments throughout the country. In January, 1943, the Industrial Protection Council of OCD was created and the N.F.P.A. was designated as one of the participating agencies, and in the fall of 1943 the National Security Award Council included a staff representative of the Association. The overall committee sponsoring the States War Inspection Service program also included a representative from the staff.

Shortly after the creation of the National Housing Agency, a program of adequate fire protection procedure for federal housing was suggested by our staff to the appropriate officials and was instituted; and throughout the war close contact has been made with the Fire Safety Section of the Federal Public Housing Authority.

An extremely important and useful by-product of the staff contacts with all these federal agencies and activities was the transmission of information and advice to our members. Through the *News Letter,* through our Fire Marshals Section, and our Volunteer Firemen's Section, members keenly interested in matters of civilian defense and protection of war plants were kept advised of the policies and procedures in Washington. Hundreds of our members engaged in various war activities have expressed to us their appreciation for this service of information which could only be maintained because of our personal contact in Washington. It is perhaps an interesting commentary to say that members of the N.F.P.A. Executive Office staff averaged one man two to three days a week in Washington throughout the entire war period.

Magnesium incendiary bomb cases being manufactured for use on German and Japanese targets burned in this $350,000 fire near Dallas, Texas, on the night of Dec. 15, 1943. Fires such as this contrasted strongly with war production conducted by established companies familiar with the hazards involved, which had the benefit of fire protection advice of N.F.P.A. members in their organizations or through insurance connections, and which generally had good fire records.

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connections, and which generally had good fire records.

Production of engines for Liberty ships was stopped in this Portland, Oregon, plant on Feb. 2, 1944. Important war plants were subject to an extensive program for fire prevention inspection in which many N.F.P.A. members participated, but many large losses occurred where N.F.P.A. recommendations were not followed and where production was concentrated in buildings of large area combustible construction with neither fire walls nor automatic sprinklers.

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neither fire walls nor automatic sprinklers.

Louisville Courier-Journal.

This butadiene plant explosion and fire in Louisville, Ky., June 17, 1945, caused damage estimated at some $500,000. While the loss was important, it was said not to have had any serious effect upon the synthetic rubber program. In the design of this plant, operated for the account of the government, the unusual fire hazard had been taken into account and the property was divided into a number of independent production units. Adjoining units were saved by operation of a water spray protection system recently installed. For safety reasons the butadiene escaping from the ruptured piping was allowed to burn until the source of supply could be valved off. No one was injured.

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V-J Bulletin. August 15, 1945.

Florida Air Base Fire.

Fire, following collapse of three Navy blimp hangars during the hurricane of September 15 which struck the Richmond Naval Air Station, Florida, destroyed 366 Navy planes, 25 Navy patrol blimps and 150 automobiles. The Naval Air Station is located 15 miles (airline) southwest from the city of Miami. The center or lull area of the storm passed over the Station. Observers at the field estimated the wind velocity to be in excess of 100 knots (114 miles) per hour. Anemometers at the field failed at a recorded wind velocity of 80 knots (92 miles) per hour. Newspaper accounts estimate the loss of hangars and contents in excess of $30,000,000.

Each hangar covered a little over seven acres in ground area, the dimensions being 1000 ft. long by 320 ft. wide by 190 ft. high. The hangars were constructed of flameproofed timber trusses and flameproofed 2-inch planking. The planking was held in place by 16d nails. Of approximately 9,000,000 square ft. of timber used in the construction of the hangars, about 7,000,000 ft. were treated.

All three hangars collapsed in a similar manner during the storm, Hangar No. 1 having the least structural damage. The trusses appeared to rise at the center, later separating in the peak. The leeward sides of the structures fell outward and away from the hangars, part of No. 1 Hangar falling on to the floor of Hangar No. 2. The windward sides fell on the hangar floors. Fire damage in the debris was greatest in Hangar No. 3 where the largest number of aircraft and automobiles was parked. Concrete buttresses spalled badly.

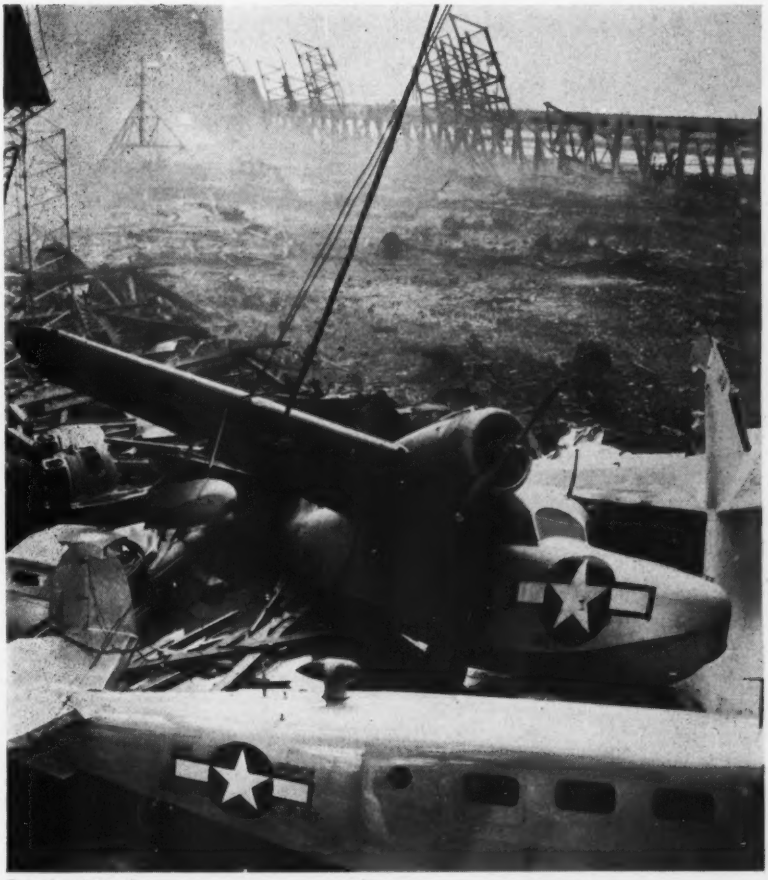
The origin of the fire is believed to have been due to ignition of flammable vapors released from large quantities of gasoline in tanks of damaged aircraft and automobiles by short circuits in the planes, cars or buildings. Hangars No. 3, No. 2, and

Miami Herald.

Richmond Naval A.S. personnel fighting fire in wreckage of flameproofed wood.

Miami Herald.

Aerial view of two of the three hangars wrecked in the hurricane at the Richmond Naval Air Station, near Miami, Florida, Sept. 15, 1945. Fire, following collapse of the hangars, destroyed 366 Navy planes, 25 blimps, and 150 automobiles. Note the unburned flameproofed wood wreckage on the ground outside the hangar floor of the nearest hangar in the photograph. Partially burned or undamaged treated timber trusses and plank sheathing can be seen throughout the ruins.

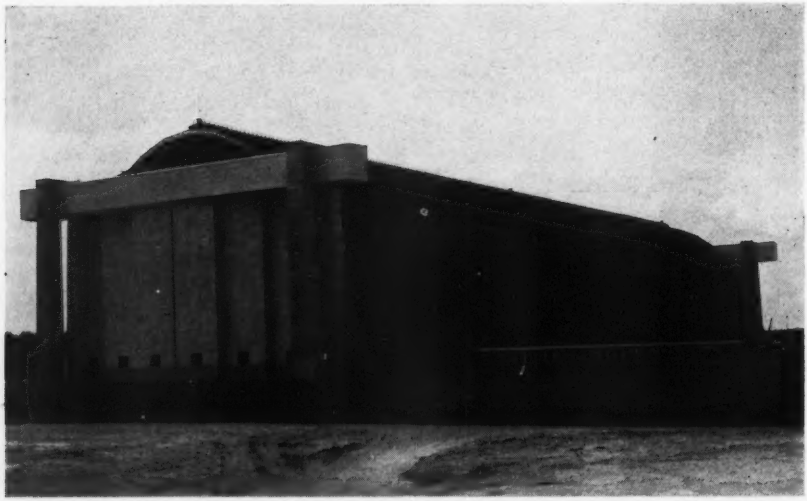


Press Association, Inc.

Fire, following collapse of three hangars at intervals of a few minutes at the Richmond Naval Air Station, near Miami, Florida, consumed wrecked flameproofed wood, aircraft and automobiles where gasoline tanks, broken by the collapsed structures, released large quantities of gasoline at the floor level of the hangars.

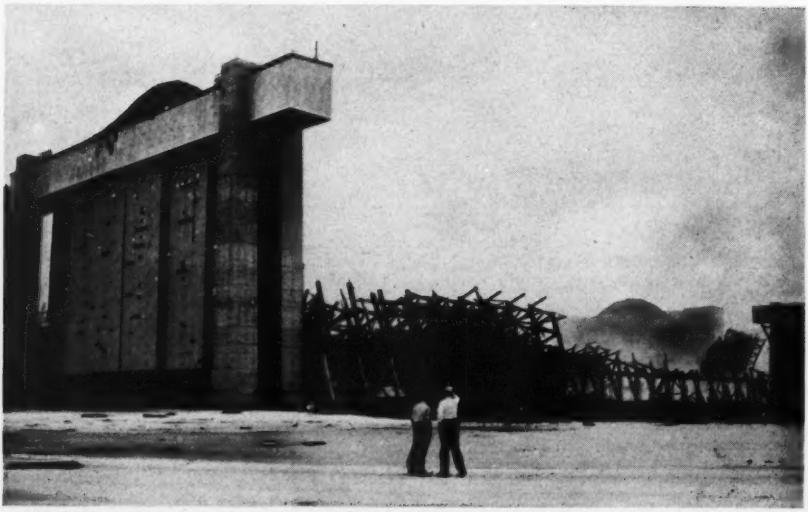
No. 1 collapsed in that order within a few minutes. Observers reported that separate fires started in the three hangars. Because the structures had collapsed prior to ignition, this fire throws no light on the frequently discussed question of the possibility of spread of fire between hangars of this type 80 ft. apart.

Considerable publicity has been given to the wartime use of flameproofed wooden hangar structures by the Navy; and the flameproofed wood, treated by a pressure impregnation process to meet Navy specifications, gave a good account of itself in this disaster. Photographic evidence (see illustrations) shows that combustion of treated members and aircraft was complete where large quantities of flammable liquids were present at the floor of the hangars. However, it will be seen that large quantities of wrecked and splintered treated wood members, immediately out-



U. S. Navy, Official.

The blimp hangar at the Naval Air Facility, South Weymouth, Mass., shown above, is similar to the hangars at the Richmond Naval Air Station, Florida, in size, construction and flameproofing treatment of wood structure.



Miami Herald.

Hangar No. 2, Richmond Naval Air Station, Florida, following collapse and fire. The raging fire, fed by flowing gasoline, did not entirely consume the flameproofed wood wreckage, but the 1000 ft. long hangar and its contents were a complete loss.

side the zone of burning flammable liquids, either resisted ignition or were only partially burned.

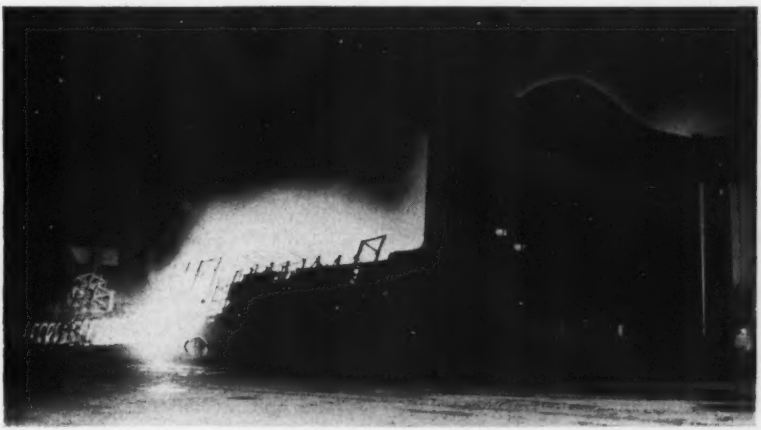
Preliminary reports indicate that there were no burning brands from the fire. It is reported and supported by the photographic evidence that fire did not occur in large masses of debris of the hangar walls which fell to leeward and away from the hangar floors.

A Naval Board of Inquiry was convened to investigate the cause of collapse and the ensuing fire damage. Its findings have not yet been made public and may not be for some time. The evidence available suggests that approximately the same loss of large numbers of aircraft and automobiles could have resulted if they had been housed in equally large area buildings of non-combustible construction, had there been equal structural failure. It appears that the flameproofed wooden material used in the construction of the hangars had only minor effect on the heavy fire loss of the aircraft parked in the hangar for safety during the storm. The photographs clearly show that masses of fractured flameproofed wooden trusses and sheathing and damaged aircraft remained after the flammable liquid fire had burned itself out. If this material had not been treated, it is obvious that total combustion would have occurred, although there would have been little or no difference in the actual loss in this case.

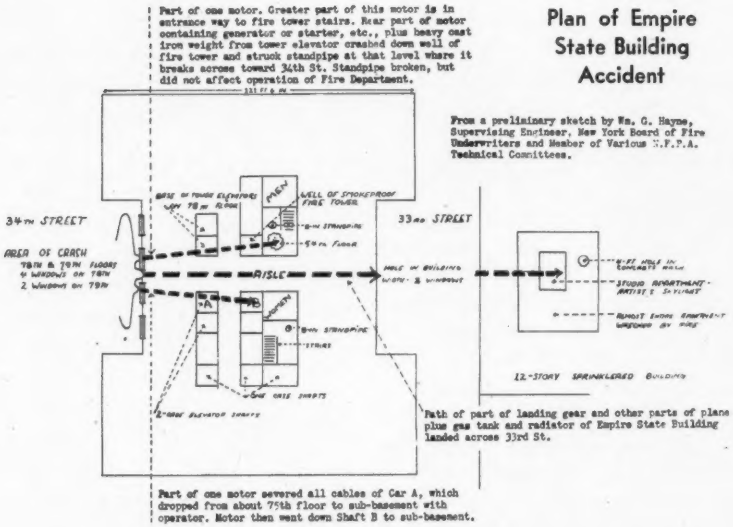
The Naval Air Station Fire Department could not have anticipated the problem with which it was faced on the collapse of three hangars within a short space of time and the fires immediately ensuing, fed from the flowing gasoline. Mr. Harry H. Schultz, civilian fire chief from Miami, Florida, was killed during the hurricane.

We learned of the effect of the hurricane on residences and other structures in the Miami hurricane area from a letter from Mr. W. H. Peace, Chief Building Inspector for the City of Miami, dated September 26, which follows in part:

"Miami is hurricane minded and our present Building Code, adopted in 1936, providing hurricane bracing and anchoring, has been very effective, as storms since that date have caused only negligible damage to structures conforming to Code requirements. During the storm period, electric current is cut by the power company and a general check-up is made after the storm, before current is released to damaged structures."



Empire State Building Fire.


Part of one motor. Greater part of this motor is in entrance way to fire tower stairs. Rear part of motor containing generator or starter, etc., plus heavy cast iron weight from tower elevator crashed down well of fire tower and struck standpipe at that level where it breaks across toward 34th St. Standpipe broken, but did not affect operation of Fire Department.
Plan of Empire State Building Accident
From a preliminary sketch by Wm. G. Hayne, Supervising Engineer, New York Board of Fire Underwriters and Member of Various N.F.P.A. Technical Committees.
34TH STREET
33RD STREET
AISLE
12-STORY SPRINKLERED BUILDING
Path of part of landing gear and other parts of plane plus gas tank and radiator of Empire State Building landed across 33rd St.
Part of one motor severed all cables of Car A, which dropped from about 75th floor to sub-basement with operator. Motor then went down Shaft B to sub-basement.

Skyscrapers which pierce the clouds of Manhattan have been one of the marvels of the modern world. Such structures are built with all the stability that can be obtained through modern engineering methods. Not only are they built of fire-resistant materials, but they incorporate extensive internal fire fighting facilities. When the world's highest structure, New York's Empire State Building, was erected in 1931, modern bombing aircraft were unknown, but recognition was given to the coming age of aviation by the inclusion of a 200-foot dirigible mooring mast at the crown of the 1248-foot structure.

Saturday morning, July 28, was rather foggy in New York. A B-25 two-engine medium bomber, in contact with La-Guardia Field by radio, disregarded advice to land at LaGuardia and started for the Newark airport. The CAA regulation specifying a 2000-foot minimum altitude for Manhattan was disregarded. The existing visibility of two and one-half miles through the mist was actually "contact visibility for the bombing plane"; as it provided perhaps 45 seconds' apprehension of objects at a speed of 250 m.p.h.

At approximately 9:52 A.M. the bomber loomed out of the fog and crashed with a terrifying impact into the north wall of the towering building, ripping a hole eighteen feet wide and twenty feet high in the exterior wall at the 78th and 79th floors. According to a report by Chief Fire Marshal Thomas P. Brophy (Member N.F.P.A.), the force of the impact caused flaming gasoline from the ruptured tanks to be sprayed on the exterior of the building for a distance of about five stories above and

Press Association.

Looking down north wall where plane struck 78th and 79th floors.

below the crash on the northwest end of the structure.

The 78th floor, which was not occupied by a tenant, was being used temporarily at the southwest end for the storage of paints and painters' supplies, to which the flames extended. The main body of the plane entered this floor through the north wall of a recess, about 60 feet from the west wall of the building. One motor demolished the base of the elevator shaft to the building's tower and walls of the fire tower. The main part of this motor stopped on this landing, but parts of it fell to the 55th floor. One of the wheels landed in elevator shaft No. 6 on the 78th floor. A propeller lodged in a partition wall.

At the point where the plane crashed into the building, an I-beam was ripped loose and twisted inward, raising a portion

of the concrete flooring on the 79th floor approximately three feet, which indicates that the plane was ascending at the time of the impact.

When the bomber crashed, part of a wing entered the west portion of the 79th floor, which was occupied by the National Catholic Welfare Conference, War Relief Services. The flaming gasoline from wing tanks sprayed throughout the north section of this area, where ten employees working at their desks were fatally burned. Fire flashed rapidly toward the south of this office and seven other employees of the Saturday morning "skeleton" shift were seriously burned, one fatally. These deaths, together with the loss of the three occupants of the plane, brought the toll to fourteen.

Parts of the burning plane, including a wheel and section of the wing, continued across a passageway and went out through the south wall, plummeting to the roof of a 12-story building across W. 33rd Street, starting a fire which caused $75,000 damage in the penthouse apartment of Henry Hering, noted sculptor.

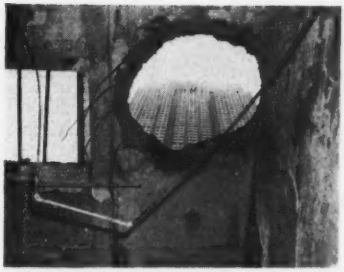
On any other weekday vastly greater numbers of persons would have been in the Empire State Building; and it is fortunate, also, that a considerable part of the area involved in the crash fire consisted of vacant or storage sections. In addition to the fourteen dead, twenty-five were injured. According to William G. Hayne, Supervising Engineer, New York Board of Fire Underwriters (Member N.F.P.A.), there was a bank of ten express elevators and one freight elevator extending up through the building. Four of the passenger elevators were definitely put out of service by the crash; and the other elevators, although operative, could not be used by the occupants because operators feared to run them. An excellent stair shaft, also a smoke-proof fire tower, extended up through the building and were tenable at all times. The greater portion of the people on the upper floors descended to below the fire by this stair shaft. It appears that no attempt was made by the tenants to use the elevators, although they were utilized by firemen. One elevator crashed from about the 75th floor to the sub-basement when parts from the plane severed all of its cables. Why the safety device did not stop this car in the shaft has not been reported. The elevator operator had a terrifying drop to the sub-basement and was seriously injured.

International.

One of twelve hose streams operated from building standpipes.

Acme.

Flames issue from west side of 79th floor where lives were lost.



International.

Hole through concrete penthouse roof across 33rd street, pierced by plummeting motor.

The building was well equipped to resist fire and apparently withstood the impact of the bomber with relatively little damage to the 56,000 ton structural framework. Although over $500,000 damage was done to the building, only about 20 per cent was fire damage.

Fire Commissioner Patrick Walsh in a report to Mayor LaGuardia, who was also early on the scene, stressed that the fire aspect was relatively easy to handle due to detailed advance planning for a fire in this structure, specialized training of fire department members for fire fighting operations in skyscrapers, provision of special high pressure pumping equipment and hose for 60 per cent of the engine companies in the department, and local building and fire protection requirements to insure maximum safety of the public in such buildings.

While many calls were received, the fire department responded to four alarms sounded over a period of eight minutes, bringing some 23 fire companies with forty pieces of apparatus. On arrival the fire department was confronted with three separate and distinct fires: one involving the 78th and 79th floors of the Empire State Building; one in lower portions of the elevator shafts; and a serious fire atop the 12-story building at 10 W. 33rd St.

The crash fire, at an elevation of 913 feet above the street, was not only the highest fire ever to occur in a building, but was a fire involving large quantities of gasoline and other flammable liquids. That these three fires were handled so expeditiously is not only a credit to the work of the Fire Department but was due in large measure to the internal fire protection features available.

The internal protection in the Empire State Building will be of some interest. There were nine 8-inch standpipe risers, totaling 7340 feet of pipe, with two risers extending upward through the main fire area to the 83rd floor. One of these risers was put out of service by the crash, but ample cross-connections made possible a by-pass of the damaged section. There were six miles of 2½-inch hose connected to the standpipe outlets, but the fire department, of course, preferred to carry up and use its own hose for the most part. In the sub-basement was a 750 g.p.m. fire pump, with similar pumps at the 20th, 41st, and 62nd floors. A 280 g.p.m. pump was installed on the 85th floor. Water

International.

Walkie-talkie radios maintained communications between street and 79th floor.

supply tanks with the following capacities reserved for fire service were provided: sub-basement, 10,000 gallons; 21st floor, 5000 gallons; 42nd floor, 5000 gallons; 63rd floor, 5000 gallons; and 85th floor, 3500 gallons. The standpipe pumps and tanks were supplied by special fire service connections to the city mains. Seven 3-inch fire department hose lines backed up by high pressure pumpers capable of operating at 600 pounds p.s.i. were connected to fire department siamese connections to the standpipes.

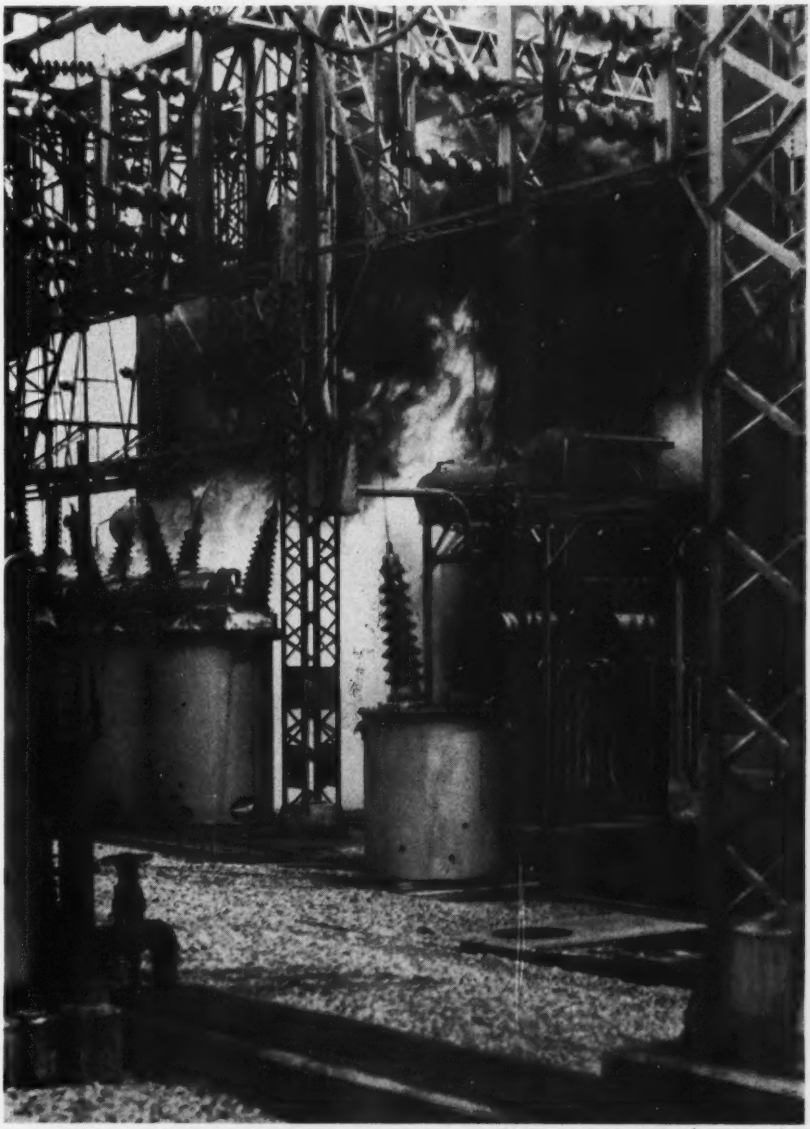
As it turned out, there was no need to pump into the building system, although the 14,000 top gallon tank, of which 3500 gallons were reserved for fire use, was running low when the fire was extinguished. The blaze was under control in nineteen minutes and completely extinguished in forty minutes from the time of impact.

Several automatic sprinkler heads in the basement reportedly operated near the elevator shafts. On the upper floors there were central station fire alarm boxes, although the first alarm was given from a near-by street box by a fire department officer who was on inspection duty. Twelve connections from the Empire State Building's standpipes at various floors were used as follows to control the fire: 1 line at the 65th floor into shafts; 3 lines to 78th floor; 6 lines at the 79th floor where the fire was most intense; 2 lines at the 80th floor. In addition, one outside line was brought in to control the fire at the first floor.

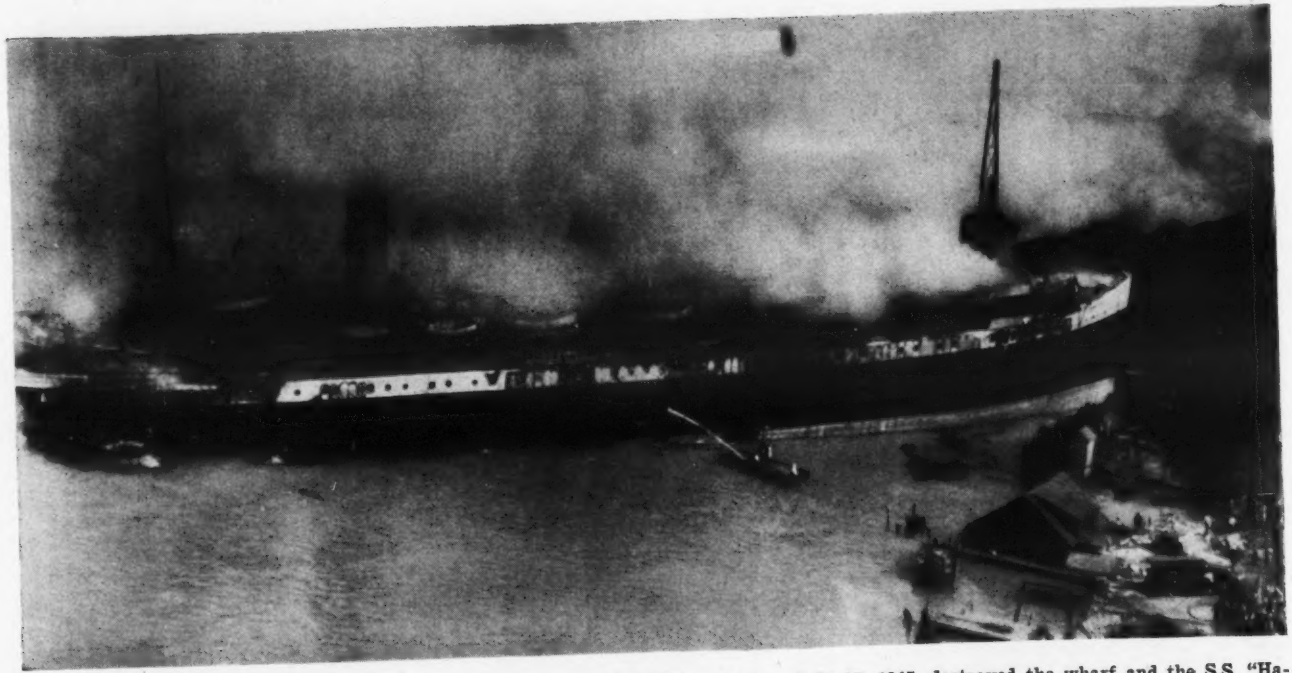
The serious exposure fire in the studio apartment atop the building at 10 West 33rd Street also emphasizes the value of strong private fire protection in an emergency. On each of the four alarms for the major fire, one or more fire companies were detached to fight this blaze. However, five automatic sprinkler heads were operating, holding the fire in check. A central station connection to the sprinkler system gave the alarm for this fire. The blaze was controlled by six fire companies using three streams from the top three connections of the building standpipe supplied by two 3-inch hose lines from high pressure fire mains. Another high pressure line backed up the sprinkler system. Initial supplies to sprinklers were a 25,000 gallon gravity tank and two 9000-gallon pressure tanks.

Excellent work at minimizing loss in both buildings was done by six companies of the New York Fire Patrol which covered contents of the floors below the fires and removed large quantities of water.

The coordination of all fire fighting operations covering three separate but related fires was greatly facilitated by the use of the Fire Department's short wave radio, including "walkie-talkie" pack sets. One walkie-talkie was used for reconnoitering between the 60th and 80th floors, relaying information to Commissioner Walsh and was particularly helpful in connection with the task of bypassing the ruptured standpipe. Station WNYF of the New York Fire Department also was an efficient intermediary between the tall building and the truck of Rescue Co. 1 at the scene. Occupants of the 80th floor telephoned to fire department headquarters that they were trapped above the fire. This information was radioed to Rescue Co. 1, from which it was shortwaved via walkie-talkie to firemen aloft, who led the tenants to safety.



This electric transformer fire at a generating station in Somerset, Mass., on July 11, 1945, interrupted electric service over a considerable area and caused a loss of $120,000. Crushed stone around oil-filled transformers limited the spread of the burning oil. Employees delayed in using hose streams, as the water supply was from a salt water river and it was feared to use salt water on a fire in a 110,000-volt transformer. Subsequently fresh water streams were used. The fresh water in contact with a high voltage insulator caused a flash to the ground, but firemen did not experience any electric shock.



Press Association.

Fire, starting on a gasoline lift truck in a frame wharf shed at Port Edward, Ont., July 17, 1945, destroyed the wharf and the S.S. "Hamonic," with a total loss of $3,000,000.

Port Edward, Ontario, Wharf Fire.

Fire at Port Edward, Ontario, July 17, 1945, starting with the backfire of a gasoline-operated lift truck, destroyed a 1150-ft. frame wharf, railroad rolling stock and freight, and a 365-ft. passenger vessel moored at the wharf, with a loss of $3,000,000. This fire presents a number of features of interest in addition to repetition of the old story of a large loss fire due to excessive area of combustible construction lacking effective protection.

Construction.

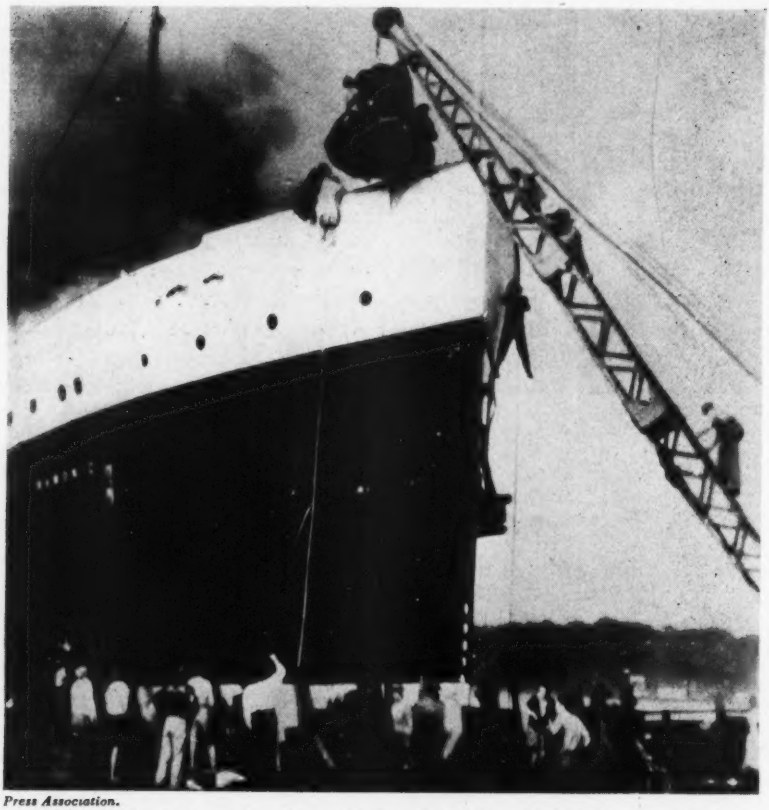
The wharf, extending along the St. Clair River for 1150 ft., was entirely of wooden construction, with no fire breaks. A pier shed along the shore, built partly over the water, was 60 to 90 ft. wide. The shed, built largely of timber salvaged when a previous structure on the same site had been destroyed by a storm in 1933, had an undivided area subject to a single fire of over two acres. The wharf was used jointly by the Canadian National Railways and the Canadian Steamship lines. Protection provided included hand extinguishers, an automatic fire alarm system and a yard hydrant system. The wharf shed was used both for the transit of passengers and the handling of freight. Railroad cars on tracks throughout the area apparently interfered with access for fire fighting, although owing to the highly combustible nature of the construction it is doubtful whether this was a material factor in the spread of the fire.

The Gasoline Lift Truck.

A gasoline-powered lift truck used for freight handling was the only vehicle of its kind in use on the premises. This truck had been out of order previous to the fire. After some repairs, it still failed to start and was taken to the battery room for recharging the battery. The battery room was a wooden enclosure in the shed near one end of the wharf. Finally after some further adjustments the motor started, but owing to over choking there was an explosion in the exhaust pipe. The exhaust manifold was broken, allowing flames to escape which ignited gasoline or oil around the motor. Employees fought this fire for some minutes with extinguishers with no success, presumably due to the fact that of the ten extinguishers reported used the majority were of the soda-acid type not suitable for use on flammable liquid fires. However, the fire did not at first appear serious, and there was no combustible material near by except for the wooden floor.

Suddenly the fire flared up, supposedly due to release of gasoline fumes from the carburetor or the rupture of a gasoline line in the heat of the fire. The carburetor and gasoline line were made of white metal having a low melting point. When the fire flared up, employees were forced out of the battery room. An explosion occurred shortly, further spreading the fire. It is assumed that this was a gasoline explosion.

From this point on the fire spread with great rapidity and quickly involved the entire open pier shed area. Port Edward firemen, summoned by the operation of the automatic alarm, were soon on the scene, but by this time the fire had spread so rapidly through the large area of combustible construction that no manual fire fighting efforts could be effective. Subsequently, fire departments were summoned from surrounding communities, but the fire still burned beyond control.



Press Association.

Eight to ten persons at a time rode to safety in the bucket of a coal handling crane. Others may be seen sliding down ropes.

The S.S. *Hamonic.*

The S.S. *Hamonic,* Great Lakes freight and passenger vessel, had come from Detroit and was moored at the Port Edward wharf at the time of the fire. The ship had a passenger list of 247, and the crew numbered about 150. The fire occurred at 8:20 A.M. while many passengers were still in their staterooms.

The fire spread through the wharf sheds so rapidly and exposed the vessel to such intense heat that the ship's superstructure was ignited before any action could be taken to move it away from the wharf.

Escape of the passengers and crew through the burning wharf shed was impossible, so the captain ordered the mooring lines cast off and moved the ship to an adjoining coal wharf. The ship's decks towered high above the wharf and there was no way to put up a gangplank or ladder. The fire on board was spreading and the passengers and crew had to escape without delay. Many slid down ropes to safety. A considerable number were taken off the ship by one of the most unusual means of escape recorded in fire protection history—a large clam shell bucket on

a crane used for handling coal. The accompanying picture shows this bucket at the ship's bow. Eight to ten people climbed aboard the bucket and were lowered to safety by the crane operator. This operation was repeated until all had escaped from the burning vessel. One crew member, reported to have fallen from the vessel, was drowned.

The passengers and crew were reported to have behaved admirably in the fire emergency. Cabins in the path of the advancing flames were quickly searched and everyone brought on deck without delay. In some cases, sleeping passengers had no time to don their clothes or save any personal effects. About 100 of those on board were taken to the local hospital for treatment for burns or smoke inhalation. There were a considerable number of painful but not serious injuries to passengers who had burned their hands sliding down ropes. All but a few of those treated at the hospital were released in a short time.

Port Arthur Elevator Explosion.

By L. C. Anderson,
Ontario Fire Marshal's Office.

A dust explosion occurred in the Saskatchewan Pool Terminal Limited, Elevator No. 5, Port Arthur, Ontario, Canada, at 10:34 A.M., August 7, 1945, which resulted in the death of 22 persons, injuries to 27 others and property damage approximating three-quarters of a million dollars. Of this elevator, the work house was completely wrecked, one storage annex damaged beyond repair and considerable damage was caused to a second storage annex.

Construction and Equipment.

Pool Elevator No. 5 was built in 1918, with a capacity of 2,100,000 bushels. It is composed of three storage units known as Annex 1, 2, and 3, and a work house which is a building 187 feet in height. The construction of the work house building and of the three annex buildings containing the storage tanks was of reinforced concrete. The work house was of reinforced concrete columns, girders and floor beams with reinforced concrete floor slabs with brick panels or curtain walls between columns and girders forming the enclosing walls. All of these buildings were connected by communicating passageways and open doorways at basement level and cupola floor level.

Only one stair and one passenger elevator, both in the same shaft and open at all floor levels to the work house, served as communication between the floor levels of this entire building. No alternative means of descent in the form of exterior fire escapes or tower stairways was provided.

The area of fixed openings in the form of windows was very small and much of the glass in the windows of the work house and No. 1 Annex was wired glass.

The tanks or bins in No. 1 Annex were open and no tanks in any of the storages or elevator heads were vented to the outside of the building.

No dust collection equipment was provided for this elevator other than the cleaning machines and floor sweeps provided for the work house only.

Electrical equipment generally was quite old and much of it was installed

Port Arthur News Chronicle.

A section of the wreckage of Elevator No. 5 after the dust explosion and fire of August 7, 1945, at Pool Terminals, Ltd., Port Arthur, Ont. Twenty-two workmen were killed and many others seriously injured. Those who have not witnessed the death and destruction caused by German V-2 weapons in England can be certain that this incident is a reasonable facsimile. Reinforced concrete walls 18 inches thick were blown out by the force of the blast.

when the Elevator was built. Electric lighting, excepting in No. 2 and No. 3 Annexes, was by exposed light bulbs controlled by ordinary toggle switches. Extension cords generally used throughout the building were of the ordinary type, the light bulb merely protected by a wire guard.

Explosion.

The operations carried on in the morning of the explosion were: (a) the loading of refuse screenings on to the Lake freighter *Sonora,* and (b) receiving of grain from railway cars. The operations had been going on for a little over two hours when the explosion occurred. The tanks from which refuse screenings were being drawn were located in No. 1 Annex; and due to the absence of dust collecting equipment, the atmosphere inside the work house was such as to reduce visibility to a considerable extent. It has been the practice of elevators at the lakehead to put all dust and refuse resulting from the handling of grain into the refuse screenings bin, consequently this operation was the dustiest of all carried on.

From the statements of eyewitnesses and those of employees outside the building, the primary explosion was in the basement of Annex No. 1 and was immediately followed by other explosions throughout the work house and the cupola house of No. 1 Annex. Due to the lack of adequate venting, the reinforced concrete wall enclosing the basement of Annex No. 1, which was 18 inches in thickness, was blown 35 feet away from the building. The brick panels or curtains in the work house walls, as well as concrete

girders, were scattered for a distance of more than 300 feet and the stair enclosure was completely blown from the building so that practically no evidence of its existence remained after the blast.

Origin of Explosion.

The examination of No. 1 Annex basement where the primary explosion was believed to have taken place revealed that the epicentre of the blast was near the north end of this basement. Distorted belt loading chutes and the markings of pendant light cords on ceilings are the supporting evidence as to the centre of the primary explosion. The only known source likely to cause ignition of a dust cloud at this point was an exposed electric light bulb, of which no trace of the bulb or cord remained after the explosion. The accidental fracture of such a bulb or even its overheating when covered with dust could provide such ignition.

Other possible sources of ignition in this immediate area eliminated include: No worker was in the immediate vicinity, so there could be no smoking or lighting of matches. There was no natural fire there and no machinery that might overheat from friction. An examination of all electrical equipment, such as motors, compensators, etc., in this area, failed to reveal any arcing or any trace of failure. Whatever the cause of the ignition, the violence of the explosion is understandable with a dusty atmosphere in the building, the quantity of static dust following two hours' operation, the interior arrangements conducive to the spread of explosion, and the lack of proper venting windows of adequate area.

Fire Fighting Operations.

Several of those killed in the explosion were blown from the building and many were found at lower levels. On the arrival of the Port Arthur Fire Department there were five men trapped on the upper floors of the work house and five men in the cupola house of Annex No. 3. Much of the grain, belting and wood used in the construction of cleaning machines was burning in the work house, and fire fighting operations had to be carried on simultaneously with rescue work, as men on the upper floors of the work house were threatening to jump. Because of the lack of alternative exits, rescue had to be effected by throwing a rope from the storage tank of a neighboring elevator (No. 4, owned by the same company), which rope was made fast to a concrete girder by one of the trapped men. A soldier led in rescue operations and was followed by Port Arthur Fireman Walter Pascoe, who joined the trapped men and fitted them into a rope cradle or boatswain's chair in which they were transferred to safety to the roof of the neighboring elevator. This rope was about 110 feet above the ground and the point from which Fireman Pascoe and the soldier worked was immediately underneath 200 tons of concrete hanging by the reinforcing bars. The five men trapped in the cupola of No. 3 Annex were in no immediate danger from the spreading fire, although suffering from shock and burns. The longest ladder maintained by the Port Arthur Fire Department, a 65-foot extension ladder, was raised from the roof of a conveyor gallery to the doorway at the end of the cupola house; and these men were assisted down this ladder which was raised in a highly precarious position by Port Arthur Fireman Roy McLennan, who mounted the ladder at considerable personal risk to carry up a lifeline to which all subsequent users of the ladder were attached. This

ladder between the buildings was also about 110 feet above the ground and at its extended length is designed to be used only with supporting poles which could not be utilized here. There were four hydrants available for the attack on this fire, but heavy stream appliances were needed in order to extinguish the fires on the upper sections due to the absence of ladders of sufficient length to reach this point. In addition to the entire Port Arthur Fire Department, an 800 g.p.m. pumper and an aerial ladder were dispatched from the Fort William Brigade to assist in the rescue of the trapped men and in the extinguishment of the fire.

Observations.

This Elevator fell far short of the requirements of the National Fire Protection Association Code for Terminal Grain Elevators. The chief items of deficiency were almost a complete lack of dust control and dust removal equipment with consequent poor housekeeping conditions; open electric light bulbs and open light bulb extension cords merely protected by a wire guard and controlled by ordinary toggle switches; tanks in No. 1 Annex were open; elevator heads were not vented through the roof; the stairway arrangements were such as to promote the spread of fire or explosion, and a very small venting area was provided due to the small number of windows, many of which were glazed with wired glass.

Recommendations.

The results of the investigation into this explosion were submitted at the inquest into the deaths of three of the men who lost their lives in the explosion. All available witnesses who could assist in determining the cause, origin and circumstances of the explosion gave evidence, following which the coroner's jury recommended—

(1) That there be regular inspection of Terminal Grain Elevators and similar plants by a qualified inspector appointed by the proper government empowered to enforce his recommendations with such necessary amendments of Provincial or

The explosion wrecked the only stairway from the elevator head house, trapping five men. The small black spot against the sky in the middle of this picture is one of the men being rescued in a bos'n's chair 110 ft. above the ground.

Dominion Legislation as may be required being made.

(2) That all Terminal Grain Elevators be required to install and maintain at all points where a transfer or movement of grain results in the liberation of dust, efficient dust removing equipment throughout the Elevator and that the dust so obtained be either entirely destroyed or stored in some separate structure, and that the removal of static dust be performed daily by men employed for this purpose, with the number so employed proportional to the amount of grain handled and the dust so taken to be disposed of as above set out.

(3) That alternative means of escape either in the form of fire tower or external metal fire escapes leading directly to the ground level should be provided from all work floor levels, and a maximum distance of travel to such exit to be not greater than one hundred to one hundred and twenty-five feet, such fire escapes to conform with the regulations of the Ontario Department of Labour.

(4) Interior stairways should be completely enclosed, the doors opening into the stairway at all floor levels. Stairways starting in the basement should terminate at the first work floor and a distinct or separate shaft enclose the stair ascending from this level to the upper floors of the work house. Passenger elevators should be enclosed in tight shafts with incombustible doors of self-closing type installed on all floors.

(5) All existing electric equipment not conforming to the regulations of the Hydro Electric Commission of Ontario should be removed and approved types installed. Fire-resistive partitions with fire doors should be provided for all horizontal passageways for conveyors or internal traffic.

(6) All Elevators should be provided with an adequate mechanical exhaust system or effective vents to outdoors for all bins, tanks, heads, boots, garners, scales, belt loaders, belt conveyors under chutes, belt discharges and trippers, all cleaning and similar machines and at car unloading hoppers.

(7) That maximum of possible amount of window areas be provided in basements, cupolas, work houses, galleries and tunnels in no case less than one square foot of explosion venting area for every 80 cubic feet of total volume and explosion type sash installed.

(8) No smoking be permitted on the premises.

(9) All equipment to be grounded for static electricity.

(10) Adequate fire extinguisher equipment should be provided internally and externally and maintain the said parts in good working condition by a specified qualified person.

(11) That adequate standpipe installations should be made in all Terminal Grain Elevators.

(12) That adequate rescue equipment, including stokes or equivalent stretchers, long ropes and long ladders be maintained at each Elevator.

(13) That the City Council and other local authorities give immediate consideration to the adequacy of the existing fire equipment. The disaster which is the subject of this inquiry would indicate that a pump with a capacity of at least 800 gallons is necessary and that an aerial ladder not exceeding 85 ft. would have materially assisted the fire department and might prevent a recurrence of a similar disaster.

(14) That copies of these recommendations be forwarded to all City, Provincial and Dominion authorities under whose jurisdiction any of the matters above referred to may come.

The N.F.P.A. Code for the Prevention of Dust Explosions in Terminal Grain Elevators is published in the National Fire Codes for the Prevention of Dust Explosions and also in separate pamphlet form. This Code, prepared by the N.F.P.A. Committee on Dust Explosion Hazards with the cooperation of the industry, was officially adopted in 1925 and has been revised periodically to keep it up to date.—Ed.

Miami Herald.

Burning of an oil reclaiming plant near Miami, Florida, July 1, 1945. Three thousand oil drums, most of which contained used airplane lubricating oil, stills, tanks and other process equipment were involved. Fire spread to an adjoining liquefied petroleum gas plant. One boy was killed by an exploding oil drum and sixteen persons were injured. Property damage $150,000.

Sacramento Union.

Buildings in course of construction often present a far greater hazard than after completion. This brick and concrete warehouse, under construction near Sacramento, Calif., burned on Aug. 22, 1945, with a loss of $313,000. Sparks from an acetylene torch ignited cork and paper used for insulation of a cold storage section. Despite the hazard of exploding ammonia tanks, firemen, aided by a fire wall, saved other sections of the large plant.

Detroit News.

This fire in the Export Box and Sealer Company, Detroit, August 13, 1945, caused the death of 15 persons, injury to 42 others, and a property loss of approximately $350,000. The fire started in a degreasing tank supposed to contain a non-flammable solvent, but in which a flammable liquid was being used.

Detroit Packaging Plant Fire.

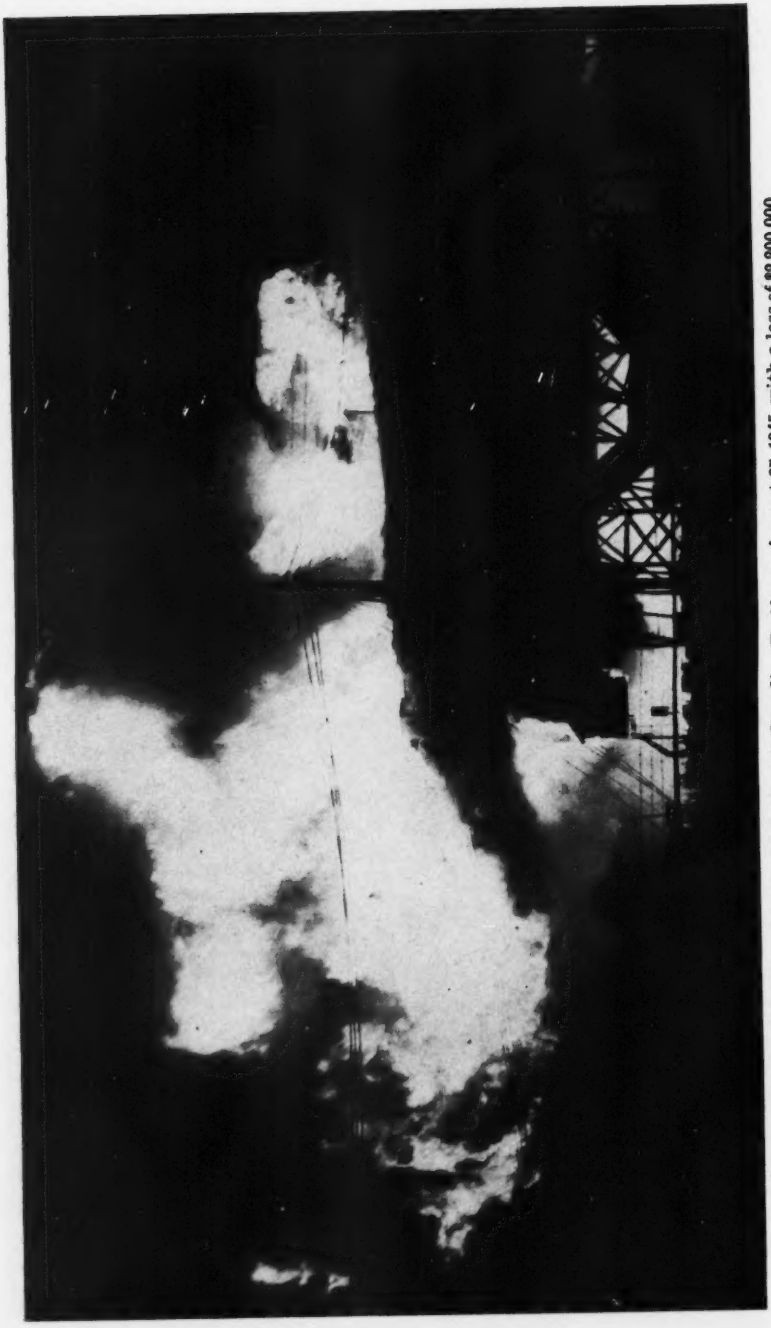
Fire in the plant of the Export Box and Sealer Company, Detroit, on August 13, killed 14 women and one man, caused injury to 42 others and property damage of approximately $350,000. The plant was a two-story structure of ordinary construction lacking automatic sprinklers or any other effective protection for the severe fire hazards involved.

The plant was engaged in packaging replacement parts for tanks and aircraft for shipment overseas. The special waterproof packings involved the use of highly combustible materials and quantities of flammable solvents. In April, 1945, the plant had been closed by order of the Detroit Fire Department because of violation of local regulations, but was subsequently allowed to reopen.

Fire started in a degreasing tank which was supposed to have contained trichloroethylene, a non-flammable solvent, but actually contained a flammable solvent at the time of the fire. The fire started during a rest period when women employees were in a recreation room on the second floor. The first shout of fire from the street floor was unheeded, perhaps drowned by the noise of a "juke" box; a moment later it was too late to escape by way of the single wooden stairway which furnished the sole means of escape from the second floor. Many jumped from windows and sustained serious injuries. The Detroit Fire Department, summoned by box alarm, responded promptly, but it was already too late for effective rescue work. Eleven of those killed were found dead or died at

International.

Ruins of the first floor after the fire. Note congestion of solvent drums and equipment. The open wooden stairway in the background of this picture was the only means of escape from the second floor.



Burning of the Citrus Concentrates plant in Dunedin, Forida, on August 27, 1945, with a loss of $2,200,000.

the scene of the fire, two died in hospitals later the same day, and two died several days later as a result of burns and injuries.

The fire apparently spread with extreme rapidity from its point of origin, owing to the presence of flammable solvents in large quantities. A number of explosions occurred during the fire, but apparently the fatalities were the direct result of burns rather than the explosions.

This fire apparently reflects disregard of the most elementary considerations of safety to life and property from fire. A hazardous manufacturing building such as this should have ample exits so as to provide a safe path of escape for employees. Under any conditions at least two exits are specified as the minimum by the N.F.P.A. Building Exits Code, and additional exits should be provided where necessary to provide a safe means of escape from every part of the structure. Any processes using flammable liquids in such quantities should be in segregated one-story buildings or conducted in fire-resistive structures so arranged as to minimize any danger to employees in other parts of the building. Flammable liquids should not be stored in quantity in main manufacturing areas. Some form of automatic protection suitable for the hazard should be provided. There is no evidence in the present case that any of these obvious features of fire safety were observed.

Burning of the Citrus Concentrates plant in Dunedin, Forida, on August 27, 1945, with a loss of $2,200,000.

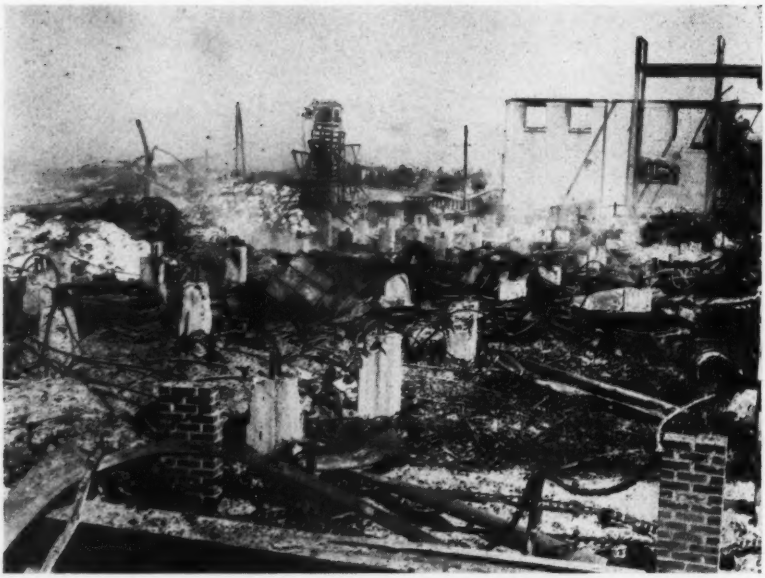
Florida Juice Plant Fire.

Fire at Dunedin, Florida, August 27, 1945, destroyed a citrus juice plant with a loss estimated at $2,200,000. This fire is of particular interest because of the large loss involved and the fact that automatic sprinklers did not control it.

This plant, erected in 1942 by the U. S. Government for the production of orange concentrate and other citrus products largely for shipment overseas, was operated by Citrus Concentrates, Inc. The plant, largely of combustible construction, covered an area of four acres with no effective fire breaks. It was said to represent the last word in efficient utilization of citrus fruit, but the results showed that fire-safety had not received sufficient consideration. The illustration on page 112 gives some idea of the character of the fire. It is indeed fortunate that this fire did not occur at an earlier date, when it might have had serious results in curtailment of supplies for shipment overseas.

The property was equipped throughout with automatic sprinklers supplied by a 100,000-gal. gravity tank and two 500-g.p.m. fire pumps, but lack of any fire stopping in joist channels rendered this protection ineffective. The main building was 400 ft. square, one unbroken fire area. The wooden roof joists, 2 x 10 in., formed open horizontal flues for 400 ft. The ceiling was sheathed with gypsum board, with fibre board beneath. The joists were supported on built-up wooden trusses also sheathed with fibreboard, making spaces that communicated with the joist channels.

The fire started inside the hollow finish of one of the trusses, presumably due to an unapproved electric lighting installation. It was discovered shortly after midnight by night watchmen who smelled smoke in the office. About this time the fire had burned down to fuse automatic sprinkler heads under the ceiling of the upper story, and the sprinkler alarm operated. The Dune-



A typical view of the ruins.

din Fire Department responded promptly, but soon realizing that the fire in such a large area of combustible construction was beyond its control, summoned fire departments from surrounding communities, including St. Petersburg.

For a time the sprinklers apparently checked the spread of fire, but eventually the flames gained the upper hand when there was not sufficient water to supply the large number of automatic sprinkler heads which had opened. There was also considerable waste of water through pipes broken by the sagging of the roof.

When the fire had extended beyond the control of sprinklers, it quickly spread and involved the entire building and an adjoining fruit storage building. Tanks of alcohol and other flammable liquids exploded and rendered fire fighting hazardous. At the height of the fire it was said that heat could be felt a quarter of a mile away. Other storage buildings and some dwellings were exposed, but were saved by firemen.

In addition to the destruction of the main plant building, the fire destroyed 150,000 gallons of orange concentrate; 150,000 cases of orange juice; 20,000 gallons of orange oil; 150,000 pounds of pectin; and 500,000 pounds of orange jelly.

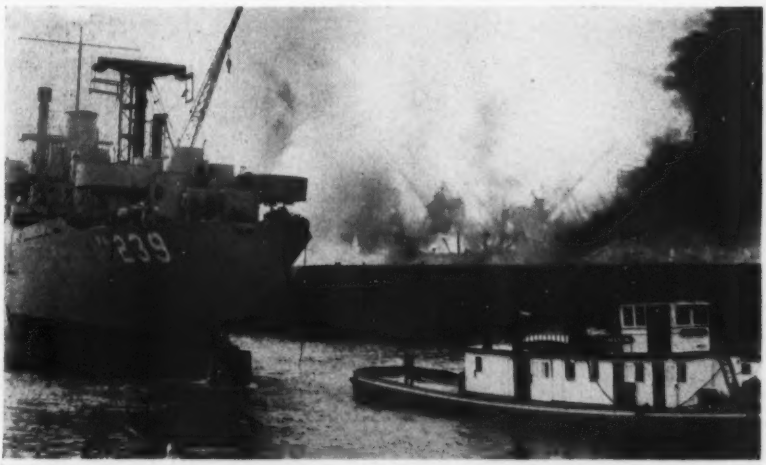
Oregon Shipbuilding Fire.

The fire at the shipyard of the Oregon Shipbuilding Corporation, August 30, 1945, resulted in a loss estimated at $3,000,000. This large loss fire was the second to be sustained at the Oregon Shipbuilding Yard, just outside Portland, Ore. On November 6, 1944, an office building, 350 feet in length constructed of combustible materials without automatic sprinkler protection burned, resulting in a total loss estimated at $600,000.

The final report of the fire damage sustained August 30 has not yet been issued. However, both the U. S. Maritime Commission and the Oregon Shipbuilding Corporation have released preliminary information to the N.F.P.A. and the final report will also be made available.

The fire was discovered under the outfitting basin wharf at 8:10 A.M. during a change in shift. Seven ships nearing completion were afloat in the basin and were lashed together alongside the wharf. Sparks from a welder's torch dropped through the wharf deck and ignited combustible material, believed to have been paper, debris and logs. First newspaper accounts of the fire stated that an acetylene line under the wharf deck ruptured and was the cause of ignition. Later investigation by yard fire officials suggested that while the acetylene line may have contributed to the rapid spread of fire throughout the under deck area, it was not the primary cause of ignition. The wharf had been provided with widely spaced sheet metal fire stops which were ineffective. Lack of automatic sprinkler protection under the wharf deck and the ineffective fire stops were responsible for the rapid spread of fire throughout the 2200 foot length of the wharf and its total destruction.

Several buildings of all-steel or combus-



International.

Outfitting basin at the Oregon Shipbuilding Corp. shipyard. Tug towing one of seven partially completed ships to safety in the Willamette River.

Milton Werschkul.

Oregon Shipbuilding Corp. fire, August 30, 1945. Part of wharf, total length 2200 ft., at height of fire. Fire spread from wharf to shops on landward edge of wharf. Fireboat in center, harbor patrol boat to the left. Four of five $75,000 cranes, two shown in photo, toppled when burning piling collapsed. Loss estimated at $3,000,000.

Milton Werschkul.

The Oregon Shipbuilding outfitting wharf an hour after the fire started. Ship at right has been pulled away from the wharf.

Oregon Shipbuilding Corp. fire, August 30, 1945. Part of wharf, total length 2200 ft., at height of fire. Fire spread from wharf to shops on landward edge of wharf. Fireboat in center, harbor patrol boat to the left. Four of five $75,000 cranes, two shown in photo, toppled when burning piling collapsed. Loss estimated at $3,000,000.

tible construction were located to the landward edge of the outfitting wharf. Occupancy of these buildings included a pipe shop, paint shop, machine shop, electrical shop, and dock offices. The wind direction at the time of the fire was favorable to the spread of fire from the wharf to the buildings erected at its edge, and they were rapidly involved in fires beyond the capacity of the combined fire protection service available to control them. Yard officials state that had the fire originated in but one of the buildings adjoining the wharf, the yard fire brigade and the Portland Fire Department could have prevented fire spread from the building of origin.

The Portland City Fire Department responded to three alarms with pumpers and three fire boats. The Coast Guard ordered 200 men from nearby Portland to the scene and they rendered assistance to the public fire service. Coast Guardsmen swam to the ships moored to the wharf and enabled harbor tugs and river steamers to tow the seven vessels outfitting to safe anchorage in the Willamette River. The vessels were only slightly damaged in the fire. Firemen were successful in saving a large machine shop adjacent to eleven shipways. Had the machine shop and the shipways ignited, it is probable that total loss of the yard, including ships on the ways, would have resulted.

Five huge cranes designed to handle prefabricated sections of ships were on the outfitting wharf at the time of the fire. After the wharf had burned for several hours, within five minutes, four of the five cranes toppled from the wharf deck when piling was weakened by the fire.

At one time during the fire it was believed that the large acetylene generating plant would become involved, and precautions were taken to prevent explosion in the event that fire reached this building.

The major contributing factor in this heavy loss was the lack of automatic sprinkler protection for the under deck space of the outfitting wharf. Whatever the reason that the N.F.P.A. "Recommended Good Practice for the Construction and Protection of Piers and Wharves" was not followed, it is certain that Code recommended transverse fire walls at intervals not exceeding 300 feet would have limited the extent of this fire. Transverse fire stopping centrally located between fire walls spaced not to exceed 150 feet would have also acted to restrict the spread of this fire. Lack of deck protection for the welding operation was a serious deficiency. The fire shows that wharf side location, construction, and protection of auxiliary buildings might have been planned to avoid rapid spread of fire from the wharf to the buildings. Present information suggests that the wartime use of combustible building material without proper safeguards contributed materially to the large loss. This yard was vulnerable to fire of this origin and extent throughout the wartime operation. Had the fire occurred earlier its effect on delivery of ships could have been extremely serious.

Nitrate Bath Explosions.

An explosion of a nitrate bath in the heat treating department of Plant No. 1 of the Iron Fireman Manufacturing Company in Portland, Oregon, August 23, 1945, caused the death of two employees and the injury of 16 others. The loss, including Use and Occupancy, is estimated to be in excess of $300,000. At about 1:00 A.M. on the date of the explosion approximately 35 pounds of aluminum alloy castings were put into the bath for heat treatment which was to last approximately 12 hours. The explosion occurred at 7:30 A.M. The mixed sodium and potassium nitrate bath normally operated at 960 degrees to 1000 degrees F. It is reported that the exact treatment temperature at which the bath had been manually set prior to the explosion is unknown. While no exact information is available, it appears reasonably certain that this bath reached a temperature of approximately 1300 to 1350 degrees for a period prior to the explosion.

The Iron Fireman plant, except for the small area of the heat treating room, was protected by automatic sprinklers. The plant was of mixed frame and wood iron-clad joisted, brick-joisted and brick semi-mill construction without any fire subdivision, covering a ground area of 77,000 sq. feet (1¾ acres). The violent explosion of the nitrate bath caused collapse of a portion of the structure in the immediate vicinity of the heat treating department and fracture of automatic sprinkler piping and risers. The explosion damaged the sprinkler installation in the balance of the plant, though not so severely as to eliminate the sprinklers' usefulness in controlling the spread of fire to the rest of the plant.

The fire in the debris of the heat treating department was apparently extinguished by the plant fire brigade and the fire department by approximately 8:30 A.M. At 8:38 A.M. fire suddenly broke out again in the wreckage from lubricating oil,

cutting oil, and kerosene which had been stored in drums in the basement of the heat treating room. The second fire was difficult to extinguish with foam or fog applicators due to its location buried beneath the debris caused by the explosion.

Aluminum and Magnesium Alloys.

The use of nitrate baths for the heat treatment of metals other than aluminum and magnesium alloys has been common practice for many years with negligible incidence of violent explosion. The requirement for heat treatment of metals of comparatively low melting points introduces added hazards, principally due to the narrow range between the temperature of the molten salt solution and the melting point temperature of the aluminum and magnesium alloys.

Violent explosion can result from two causes, independently or in combination: (a) impurities in the nitrate salts or the decomposition of the salts in solution or (b) through a chemical reaction between the melting aluminum or magnesium alloys and the nitrate salts. If the temperature in the bath is permitted to reach the point at which the aluminum or magnesium alloys melt, it is believed that rapid oxidation of the metal continues even though the heat medium has been shut off automatically or manually. It, therefore, is of very great importance that the chemical composition of the nitrate solutions be checked at sufficient intervals to assure the operator that impurities have not contaminated the salts in the solution, causing decomposition at lower than normal operating temperatures, and it is equally important that the exact melting temperature of the aluminum or magnesium alloys is accurately determined to provide accurate knowledge of dangerous limits in bath temperatures.

Because of the narrow temperature ranges, the accuracy of the automatic temperature control devices is also of extreme importance. In the instances of explosions studied, the construction of the baths differed and no bath construction failure was reported. It is important that sufficient points of temperature recording in the bath be provided to assure that the temperature controls are activated by the actual temperature of the solution throughout the bath rather than at points which might be locally cool or overheating. A single means of automatic control is apparently not sufficient and in addition to automatic controls the provision of a remote manual control in a safe location is advisable.

The possibility of violent explosion in the event of overheating the salt solution with aluminum or magnesium alloy castings in nitrate baths is so great and the probability of loss of life in such explosions so great that the provision of an automatic alarm device arranged to warn plant personnel when critical temperatures are reached is advisable.

The hazards of employing inexperienced personnel to supervise operation of nitrate baths with aluminum and magnesium alloy metals is so serious that plant managers would be well advised to give consideration to the complete shutdown of the operation if qualified personnel is not available.

Important Factors.

The explosion at the Iron Fireman plant, involving the use of nitrate baths for aluminum and magnesium alloy castings, is but one of three which have been reported to the N.F.P.A. since the use of aluminum and magnesium alloy metals has become prevalent.

An explosion of a nitrate bath in which magnesium alloy castings were being treated occurred April 19, 1943, in the plant of the North American Metals Corporation, Los Angeles, Calif. The explosion resulted when magnesium alloy castings were dipped in a bath intended for aluminum alloy castings. Loss of plant and equipment was nearly total in this instance.

A well-documented report was received in connection with the explosion of the nitrate bath and fire at the plant of the Modern Foundry and Pattern Company, Vernon, Calif., April 29, 1945. Total loss of building and contents in this case was estimated to have been $100,000.

Comparison of the loss reports in which explosions in nitrate baths have produced loss of life and destruction of property develops several factors which were common in each of the explosions studied:

1. Personnel inexperienced or lacking knowledge of the explosive possibilities were responsible for maintaining the required temperatures in the nitrate baths. It appears that a particularly prevalent hazardous practice was to depend on watchmen employed during the period the plants were not in operation. They were not familiar with the narrow and critical temperature range and had instructions to phone plant superintendents for instructions if temperature rise was noticed during hourly rounds.

2. In each case reported in which a violent explosion of the nitrate bath occurred, failure of one or more of the automatic controls of bath heating devices contributed to the resultant explosion.

3. In no case were automatic alarms provided to indicate that solution temperature in the bath had risen to the limit dangerous to personnel.

4. In the cases studied the nitrate baths were located in buildings of combustible construction or had combustible materials stored in or near the location of the baths or a combination of both conditions.

5. In all cases studied the salt used in the bath was supposedly a 50-50% solution of potassium and sodium nitrate.

6. In those instances for which there is information there was loss of life or very narrow escape from death for employees or firemen.

7. In the instances studied the heat treatment departments were not protected with automatic sprinklers.

8. In each case studied aluminum alloy or magnesium alloy metals were being treated. There is no information available as to the exact melting point of the metals being treated at the time the explosions occurred. In one explosion, the melting point of the aluminum alloy casting was believed to be 1075 degrees F.

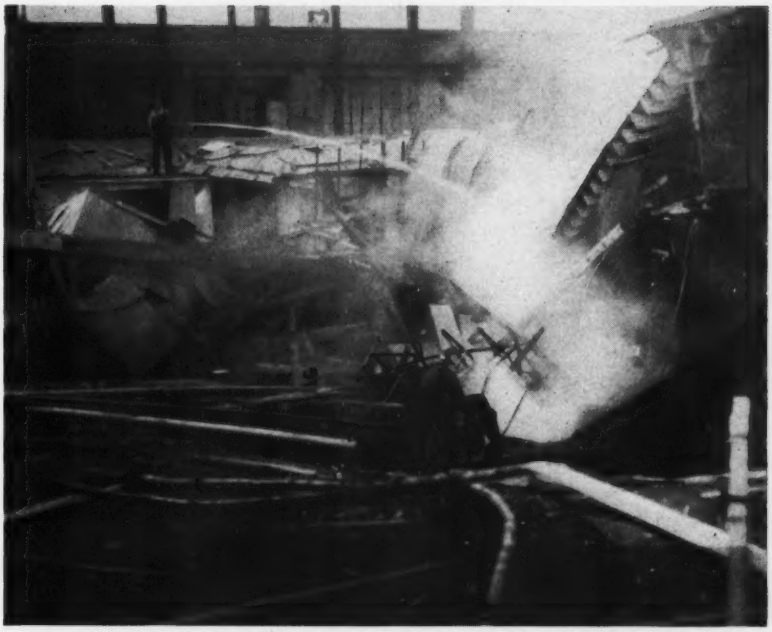
9. In no case were the manual controls located at a safe distance from the overheating furnaces.

10. None of the cases studied, which resulted in violent explosion, involved leaking bath tanks which is commonly understood to be extremely dangerous and an almost certain explosion possibility.

Precautions.

There are no official N.F.P.A. standards on this subject; but the fire experience studied and the available sources of information indicate the following precautions:

Nitrate baths and heat departments should be housed in non-combustible buildings. The construction of furnace and bath should be such that there is no possibility of molten nitrate reaching incandescent material. The room in which the process is located should be well ventilated to remove possible poisonous fumes. Prudent operators will make certain that no water is permitted to come in contact with the molten bath surface either



An explosion of a nitrate bath in heat treating department Plant No. 1 Iron Fireman Mfg. Co., Portland, Oregon, August 23, 1945, killed two employees and injured sixteen others. The explosion and ensuing fire was caused by overheating of nitrate bath in which 35 pounds of aluminum alloy castings were being treated. Loss estimated $300,000.

by introduction through operation of automatic sprinklers, rain through ventilators, poorly dried castings or any other source. Explosions have resulted from failure to remove scale and small metals parts from the bath and from uneven heating of the bath by the furnace. Cyanides should not be permitted in a nitrate bath without prior careful cleaning of the bath. Cyanide salts added to a nitrate bath will result in a violent explosion.

Other precautions include posting of signs warning fire departments and plant personnel of the hazards of the use of water in the extinguishment of fire involving a nitrate bath. Asbestos aprons, gloves, and gas masks should be provided for personnel engaged in this operation. Dry sand is reported to be the only satisfactory extinguishing agent thus far used in extinguishment of fires in this hazardous operation.

SOURCES OF INFORMATION. Information is available from the Card Data Service of the National Board of Fire Underwriters, 85 John Street, New York City. Cards, Serial numbers NB 211, NB 213, and NB 215 cover the hazards, safeguards and explosion possibilities of nitrate baths. The Inspection Department of the Associated Factory Mutuals, Boston, Massachusetts, is engaged in investigation of the problem. The Factory Department, Ministry of Labor and National Service, London, England, published a "Memorandum on Precautions in the Use of Nitrate Salt Baths," printed in June, 1944, obtainable by American and Canadian members through the British Information Services, 30 Rockefeller Plaza, New York City, which is a very good treatment of the hazards and methods of prevention of explosion.

Plastics.

By A. H. Boothby,
Improved Risk Mutuals.

Plastics include a wide variety of materials, literally anything that is moldable. Many of these plastics are new, synthetic materials; others have been in use for a long time. One of the older plastics, pyroxylin (variously known as celluloid and by other trade names), is a highly combustible nitrocellulose product, which ignites or decomposes at relatively low temperatures, burns rapidly, cannot be extinguished by smothering once any quantity is ignited as it contains its own oxygen, and may produce quantities of noxious gases. The fire hazard of pyroxylin in the form of motion picture film, X-ray film, and its various molded products is fully familiar to the fire protection fraternity. The N.F.P.A. Committee on Hazardous Chemicals and Explosives has developed standards for its storage and use, and the observance of these standards reduces the hazard to a minimum, so that pyroxylin, with proper precautions, can be used with reasonable safety in the many applications for which it is suited.

Other plastics do not have the same burning characteristics as pyroxylin and present no undue cause for concern from the point of view of fire hazard. Some plastics have a very low order of combustibility, and none, except pyroxylin, present any greater fire hazard than wood, paper and other ordinary combustible materials. Like any combustible material, the burning characteristics of plastics depend upon the form of the material, and finely divided material burns more readily than large pieces. In the form of dust, there may be a dust explosion hazard as with any ordinary combustible material.* Flammable solvents are commonly used in manufacturing operations where plastics are handled, and in such cases the characteristic hazards involved in the use of flammable liquids will be found. The manufacture of many of the synthetic plastics involves hazardous operations which present specialized fire protection problems outside the scope of this article.

The term plastics refers to any of a large group of natural and synthetic organic materials derived from cellulose, proteins, hydrocarbons or resins which are molded (under heat and pressure), extruded, cast or fabricated into various shapes. The oldest of the group of plastics now manufactured is cellulose nitrate, known technically as pyroxylin, or popularly by the trade name "Celluloid." Natural resin and shellac molded objects of unknown antiquity have been found in Indian remains in the Southwest. Methods of working pyroxylin were developed 70 years ago and are still fundamental in many of the branches of the industry.

Plastics are produced from wood, cotton, straw, bagasse, petroleum, coal, casein, carbon dioxide, castor oil, turpentine, acetylene, etc. The list of plastics is very long and includes such materials as synthetic rubber, nylon, shellac, lacquers, adhesives, etc. (See page 134.)

Plastic material manufacturing processes are involved and cannot be treated in this article. War demands have spurred the development of new materials and techniques of manufacture which have been revolutionary in some cases. Long

*See N.F.P.A. Code for Prevention of Dust Explosions in the Plastic Industry.

strides have also been made in the development of adhesives which permit the bonding together of metal, wood, plastics, ceramics, fibers and rubber in any desired combination, which are said to form structures that are stronger, lighter and cheaper than those joined by conventional methods. These new techniques and materials all add up to a vast new field for plastics in the post-war period, such as housing units, automobiles, planes, railway equipment, refrigerating devices, business machines, furniture, etc.

The following is taken from a letter recently received from one of the largest manufacturers of plastics in this country and is of special interest.

> Few people not directly connected with the industry realize how rapidly it has grown in the past ten years and what a broad scope there is to the properties and characteristics of the many types now manufactured. When you speak of "plastics" you are speaking of a type of material that differs as widely as metals. Some of those now in use are only one or two years old, and no one company manufactures more than a small part of the total number of plastics now in use.

Tests and Specifications.

The identification of organic plastic materials is very difficult even for those familiar with the field. The difficulty is caused by the similarity of many types of plastics, presence of plasticisers and fillers, and lack of simple specific tests for most of the plastics.

Test methods have been used by technical and professional workers that require considerable expert knowledge and some laboratory equipment and are as follows: decomposition by heat, behavior in solvents, physical and chemical constants, chemical classification, chemical analysis and separation of mixtures.

Complete testing methods and specifications have been prepared by the American Society for Testing Materials, also by the Federal Government. The latter specifications are available from the Superintendent of Documents, Washington, D. C. Methods of testing are also listed in the 1944 Plastics Catalog under the following groups: Mechanical, Thermal, Optical, Electrical, Permanence and Miscellaneous Properties.

Types of Materials and Uses.

Plastic materials can be obtained from a large number of manufacturers for molding and fabricating into a wide variety of products. These materials are supplied in the form of molding powders, granules, rods, tubes, sheets and shapes.

Plastics in general can be classed under two headings as regards their molding characteristics, namely, thermosetting and thermoplastic plastics.

Thermosetting plastics are those that undergo a chemical change and solidify upon the application of heat and cannot be reheated for future use.

Thermoplastic plastics are those that soften upon the application of heat and remain soft permanently under heat. All molding materials are thermoplastic at the initial application of heat.

Plastic materials in the form of resins, cellulose acetate, ethyl cellulose, nylon, shellac, bagasse and other agricultural products are available in the form of granules for the molding of large varieties of products.

Cellulose nitrate plastic has never been successfully used in the form of molding powder. It is available in the form of lacquers, emulsions, sheets, rods, tubes, color chips and beading. It can be molded by heating at 160° F. to 220° F. and

pressing in mechanical or hydraulic presses. It is rather widely used in industry and is sold under various trade names, among which are Celluloid, Fiberoid, Nixonloid, Pyralin, Viscaloid, Xylonite, Hercules C.N.

Casein and other protein plastics are available in the form of sheets, rods, tubing and discs for fabricating into small parts such as buttons, buckles, beads, airplane bushings and novelties. No practical protein molding powder has as yet been developed that can meet the standards of quality and economy of resins and other molding materials.

Fillers for molding compounds are classed as organic and inorganic. Organic fillers include woodflour, walnut shell flour, cotton flock, etc.

Inorganic fillers include asbestos and diatomaceous silica (a fine, usually white siliceous powder composed chiefly of diatoms).

Few resins possess in their unmodified form all of the properties which best suit them for specific commercial use. To develop these properties it is often necessary to add modifying agents, such as fillers, coloring materials, lubricants, stabilizers, solvents and plasticizers.

Plasticizers perform the function of making the plastic material soft and more flexible.

The list of plasticizers is a long one, and the reader is referred to the Plasticizer Chart published as part of the 1944 Plastics Catalog.

Flash points of plasticizers range from 230° F. to around 525° F.

The addition of plasticizers to flame-resistant plastic materials in large amounts may, however, render the whole material flammable.

Coloring Materials for plastics are modern synthetic or processed coloring agents. There are over 500 synthetic coloring agents in the United States, but few of these can be used to best advantage to color plastics unless produced as derivatives having special chemical and physical characteristics that adapt them to the purpose and product.

The subject is not a simple one, and a dye that is suitable for one type of material or process may be useless for another. Plastics may be colored by blending a suitable coloring agent into molding powder, by milling (heavy rolls similar to those in rubber mills), by coloring granules, by mixing colors into varnishes, syrups and emulsions and by various other methods.

Applied Coatings for plastics (other than metal coatings), consisting of lacquers, enamels, paints, etc., have necessitated a difficult operation due to the fact that the solvents used in lacquers are in most cases a solvent for the plastics. This has been overcome by developing a lacquer formula for each plastic formulation and for almost every condition of use. By using the proper coatings, however, plastics may be made impervious to certain chemicals, surface finishes may be hardened, heat resistance may be improved, water absorption lessened and impact strength regulated. Cellulose acetate plastics usually require a special sealer coat before applying the lacquer. Coating of cellulose nitrate plastics gives best results with lacquers having a cellulose acetate base.

Thermosetting resin can best be coated by using a baking enamel of urea-modified alkyds or blends of resins with oil-modified alkyds. A knowledge of the properties of the plastic to be coated and of the components of the coating solutions is necessary in every case.

Coatings for Paper have made rapid strides recently due to many materials, in-

cluding oils and other liquids, being packaged in paper containers.

The development of new resins has revolutionized the packaging industries, and traditional methods are rapidly becoming obsolete. Paper to be used for lacquering should have a hard surface, and a super-calendered or coated sheet produces the best results.

The lacquer coating usually is applied by means of a "doctor" roller running in a tank of the coating material, which regulates the amount of lacquer coating applied to the paper. After coating, the paper is dried in ovens with steam, hot air, gas flame or with infra red lamps as a source of heat. One method uses sufficient heat to melt or flow synthetic coating materials, and a temperature of 400° F. is employed from five to ten seconds, after which the heated sheet is passed through a regular oven at 150° to 200° F.

Coatings for Textiles: Various types of textiles are coated for waterproofing, mildewproofing, fire and hydrocarbon resistance, decorative and other purposes. Among the coated fabrics for military uses are raincoat and other clothing materials, utility cloth coated blue on one side and yellow on the other for use as a sail and camouflage in open water at sea, tent material, hospital sheeting, waterproof covers for blankets, bedding bags, airplane wing covering, etc. Two general types of application are used: calendering and spread coating. One other process, used to a limited extent, is laminating a preformed film to fabric.

Coatings are drying oil coatings, lacquer type coatings, rubber and synthetic rubber coatings. Drying oil coatings generally consist of a treated vegetable oil composition whose "set-up" is accomplished by a chemical change. Application is usually by spreading and finish by drying. A typical example is oil cloth.

Lacquer type coatings differ from the above in that the "set up" of the film is accomplished by the evaporation of the solvent, rather than from a chemical change. Pyroxylin or lacquer type coatings are the oldest in use and have been used in the manufacturing of artificial leather, book bindings and covers and a variety of other products. They are usually applied by spreading, spraying, barrel tumbling and dipping. Solvents are alcohols, acetone, ethyl acetate, etc., all of which are highly flammable.

Due to war conditions requiring coated fabrics to withstand both high and low temperatures, to undergo sterilizing and laundry treatment, to resist the penetration of war gases, mold and mildew, hydrocarbons, etc., and to be non-flammable the use of pyroxylin coatings has been superseded by the use of film-forming resins.

Solvents are alcohols, esters, ketones, hydrocarbons, etc., all of which are flammable. Application is by spreading.

In processes using pyroxylin or resin type coatings, the finished product may be passed through a dryer which removes the solvent, and in many cases the solvent is recovered by activated carbon or scrubbing methods.

Chlorinated Rubber is used as a coating for swimming pools, sparkproofing of concrete floors, ingredient of paints and quick drying enamels, printing ink, varnishes, etc. Solvents used are ketones and hydrocarbons. This material has been scarce during the war due to the shortage of natural rubber, which is the chief ingredient used in its manufacture.

Adhesives made from synthetic resins find a wide application in bonding many materials, such as wood, metal, plastics, rubber, etc. They are divided into two

classes, namely, thermoplastic and thermosetting adhesives. Where high temperatures are encountered, thermosetting plastics are more suitable due to the fact that the bond would be weakened if a thermoplastic adhesive were used. Materials under the thermoplastic heading are cellulose nitrate, cellulose acetate, cellulose acetate butyrate, cellulose acetate-propionate, methyl cellulose, acrylic resins and alkyd resins. Those under the head of thermosetting resins are phenolic, amino and allyl resins. Under rubber base adhesives are those made of natural rubber, chlorinated rubber and synthetic rubber.

Protein adhesives include casein, blood albumin, animal glue and soybean glue. Other adhesives are asphalt, shellac and vegetable starch. Thermoplastic, thermosetting and rubber base adhesives contain volatile solvents, such as alcohol, hydrocarbons, ketones and esters. Protein adhesives are soluble in water. Shellac is soluble in alcohol.

One of the largest users of resin adhesives is the plywood industry due to the strength of the bond, time saved in setting, ability to make cured or molded articles, resistance to mold and fungi, reasonably low cost, etc. Typical plywood applications are airplane construction of wing, fuselage and tail assemblies, marine construction of boats, pontoons, landing barges and many other items of equipment, packing cases and drums, plywood tubes and pipes, prefabricated houses.

Laminates are made up of a filler consisting of layers of paper, cotton fabric, asbestos paper and fabrics, and fiber glass cloth, impregnated with a synthetic resin. Sheets, tubes or rods can be made by varying the method to suit individual cases.

These products find wide use in the electrical and mechanical fields in gears, nameplates, furniture and table tops, dials, etc. Some of the more familiar trade names are Formica, Micarta, Textolite, Panelyte. These materials have excellent fabricating qualities and can be sawed, drilled, punched, tapped, milled or turned on the standard machines which are suitable for soft metals.

Vulcanized Fibers, discovered about 1846, were first made in this country about 1873. This product is a tough, resilient, hornlike substance having great mechanical strength, high dielectric strength, excellent machinability, good forming qualities, high resistance to wear and lightness in weight. It is made of pure cotton cellulose paper treated with zinc chloride which produces a sticky gelatinous substance. (The gelatinizing action is stopped by immersing the material in a series of tanks containing progressively lower concentrations of zinc chloride, until all traces of this material are removed.) It has wide application in the manufacture of electrical insulation, gears, cams, pulleys, gaskets, spools, trunks, welders' shields, service gas and jettison tanks for planes, identification tags, etc.

Synthetic Fibers such as nylon, vinyl resin fibers, cellulose acetate rayons, viscose rayons, vinylidene chloride fibers and plastic coated fibers have found wide use in yarns for stockings, parachute cloth, window screens, brush bristles, gloves, bandages, bathing suits, girdles, shoes, clothing, cord for heavy pneumatic tires, innersoles, etc. Protein fibers made of casein, soybeans and egg albumen (more or less experimental at present) find a variety of uses which includes blending with wool, cotton and rayon for the manufacture of hats and clothing.

The manufacture of some of these fibers involves the use of acetone and other flammable solvents. The use of the rayon fibers

in manufacturing clothing and fabrics is comparable in hazard to the use of cotton.

Rubber-Like Plastics: There are five commercial types of products that are ordinarily classed as synthetic rubbers. They are commonly known as Buna N, Buna S, Neoprene, Butyl and Thiokol. These materials are manufactured by some of the larger chemical and oil companies and in government plants. Processes involved are complicated and technical and beyond the scope of this article.

These plastics find a wide field of usefulness in rubber products formerly made from natural rubbers, such as automotive and airplane tires, gasoline and oil handling hose, linings for bullet-proof fuel oil tanks, gaskets, valve caps, clutch and brake linings, rubber soles and heels, rubber boots, gloves, insulation for electric wires, coated fabrics for balloons, waterproof clothing, etc. No one type is suitable for all uses and careful study and selection are necessary for best results.

Certain types can be used in the form of molding powders, also for hot spray powder coating of metal and similar surfaces by being sprayed through a hot flame. This type of coating gives a hard but flexible surface which is highly resistant to solvents, has very low moisture absorption and is corrosion resistant.

A recent development, known as water dispersions, consists essentially of suspensions of organic polysulfides in water. This can be applied by spraying, brushing, dipping or spreading and yields a tough elastic film which shows promise of wide application as elastic coating.

Methods of Forming Plastic Products.

The most common products are molded due to the ease of forming intricate shapes by this method. There are several methods of molding, the most common of which are compression molding and injection molding (including jet molding). Other forming methods are extrusion, molding with high frequency power, stray field heating, blowing, casting and drawing.

Compression Molding consists of introducing preformed, powdered or granular material directly into an open mold cavity. The mold is then closed, and heat and pressure applied simultaneously, causing the material to flow and fill every part of the cavity. The mold remains closed and under pressure until the material is set by heat or by cooling. Most materials can be compression molded. Thermoplastics have to be hardened by cooling the mold with water or other means.

Injection Molding is a method whereby plastics are forced under pressure from an exterior heating and melting cylinder into a cool closed mold. Ordinarily, materials for injection molding are of the thermoplastic type. However, under certain conditions, thermosetting types of materials can be injection molded.

Jet Molding is a method for a continuous injection molding of thermosetting plastics and can be adapted to most standard injection molding machines.

Molds for plastics must be carefully made of a good grade of steel that will hold its shape and dimensions throughout the various machining and hardening processes encountered in manufacture of the mold and withstand the pressure used in molding and forming the plastic product it is designed to produce. Every mold that is constructed is an individual problem and must be made to suit the material that is being used so as to produce the best possible finished product.

Temperature and Time Control are of the utmost importance in plastic molding due to the critical properties of present

plastic materials. Temperatures too high or too low, molding cycles too long or too short result in rejects which mean waste of time, labor and materials. The importance of automatically controlled operations requires a careful analysis of each installation by instrument engineers.

Extrusion is a process whereby thermoplastic materials are fed into an extruding machine and then forced through a die head which forms the material into the desired shape or form. Extrusion differs from injection molding in that there is no restraining force on the extruded material after it passes through the die, as in the injection mold.

Continuous Dry Extrusion is a technique of almost uninterrupted production. The plastic in powder, granules, cube or sheet form is fed constantly into a heated cylinder or extruder, where it forms a molasses-like mass. Pressure forces the plastic through an orifice in the die, the shape of which determines the shape of the finished product. As the hot plastic comes off the die it is cooled by air or liquid and then conveyed to a winding or cutting machine. Threads, rods, tubes, strips and odd shaped sections can be made, but only a few are ready for use when they leave the extruder. Many uses are being found for these continuous lengths and have focused new attention on the extrusion method.

Continuous Wet Extrusion at present consists of the manufacture of rods for screw drivers and tool handles, soft hammer faces and mallet heads for specialized industries. Raw stock is cellulose nitrate (burning rate "High"). This process is carried on by only a limited number of concerns in the country, principally because the preparation of the raw material is a very important part of the process.

The extruding machine may be of the hydraulic or the screw type, either of which heats the materials and forces them through the die at the nozzle, and the finished rod, tube or sheet appears. The dies may be single or multiple and form one or more sections at a time. This process has greatly reduced the cost of rods, tubes, etc. Due to the plastic material used (cellulose nitrate) this process is hazardous

Molding with high frequency power is one of the newer developments in the plastics industry that is daily solving seemingly impossible problems of plastic production. In the airplane field it is being used to overcome what were considered insurmountable difficulties in the production of propellers made of impregnated wood, laminated box spars, bomber floors, bomb bay doors and many other aircraft parts. Tests are being made on its possibilities for making different types of molded plywood forms such as wing elements and fuselages.

The material to be heated is a non-conductor and is placed between two metal electrodes, and the combination represents a "capacitor" in which the electrodes are the plates and the molding material is the dielectric. When the plates are connected to a radio frequency generator the material is very quickly and uniformly heated. The general opinion appears to be that small radio frequency units installed in a strategic position with sufficient power to handle a few presses or operations give the least trouble and provide the most economical operating costs.

The idea of installing one large central radio frequency generator has been given considerable study, but the problem of wiring facilities with radio frequency power is a difficult one. Nothing definite in the way of a standard design or system has been offered up to this time.

Stray Field Heating: Another form of heating known as stray field heating, while more complicated than radio frequency heating, offers great possibilities in speeding up the fabrication of plywood parts. In this case advantage is taken of the fact that the electrostatic field set up between two adjacent conductors or electrodes does not travel in a straight line between these conductors. The field spreads or widens as it leaves one electrode and finally converges as it reaches the other. Thus, it is possible to reach glue lines and surfaces that are not in direct line with the electrodes. This form of heating has not been used to any great extent to date, but it is believed to have good possibilities in the manufacture of wooden aircraft and glider parts, large plastic moldings, etc., and will result in greatly improved finished products.

Blowing Thermoplastics consists of expanding plastic sheets by air or steam introduced between them while they are clamped between the halves of a mold. This technique dates back to the early manufacture of hollow pyroxylin articles. Considerable research has recently been carried on and new methods developed.

The internal surfaces of blown plastics have a luster and smoothness unobtainable by other methods. This process also does away with the expensive problems of fixtures, buffing and handling which were necessary when parts were molded in halves and cemented together by former methods.

Cast Plastics: The problem of obtaining a useful thermoplastic casting material is a difficult one and up to the present time only a few of the many types of commercially available thermoplastic materials can be compounded so as to be cast with the application of heat alone.

Ethyl cellulose base materials and phenolic resins have met these requirements, and other types will undoubtedly be developed in the future. Up to the present time, cast thermoplastics have been applied almost exclusively to the production of various types of tools, such as drop hammer punches, nest blocks, drill jig bases, hand block forms, router blocks, saw fixtures, etc.

Casting materials are available in solid and liquid form, and the latter may be used either hot or cold. After pouring, the casting requires curing, which can be done by heat, acid or a combination of both.

Cast thermoplastics may be dyed in a large variety of colors by dipping in a hot bath composed of dyes, glycerine and butyl alcohol.

Drawing of Thermoplastics is now successfully done in a manner somewhat similar to the drawing of sheet metals, except that the plastic materials must be preheated or heated in the drawing die to permit deep drawing. Thermoplastic materials most frequently used for drawing are cellulose acetate, ethyl cellulose, vinyl co-polymer resin and cellulose nitrate sheeting.

Fabricating and Finishing.

Most parts produced by compression or injection molding require some kind of finishing operation before they are ready for use. This takes the form of removal of flash, gates and fins, drilling and tapping of holes and various other machining operations. In general, all plastics may be machined by equipment and technique similar to those used for soft metals and wood. Tools, however, should be of high grade and maintained in good condition in order to avoid overheating.

Assembling of plastic pieces may be done by means of machine screw inserts, riveting, threading (in larger parts), thread producing screws and drive screws, hot irons and cementing. The cements set quickly and form a bond as hard as the material itself.

Marking of Plastics is done by hot rolling of leaf on a plastic surface, hot stamping, branding, printing, acid etching, pantographic engraving, silk screening. The first three processes require a suitable press with a heated brass or steel die or type and a roll of suitable leaf which passes across the surface of the die. Printing is done on name plates by printing on one piece of opaque plastic and then laminating a protective shield of thermoplastic plastic over it. Another process uses a special marking compound which does not require after-lamination to make the marking durable.

Machines have also been developed which apply up to seven different colors in molded depressions in the plastic part. Thermoplastic materials can also be printed by rotary presses, offset presses and by the letterpress, the latter being the most common method. The principal problem in this method is in getting a proper ink, due to the fact that plastics do not absorb the ink as is the case with paper or other porous materials. Special inks with an oil base, composed of suitable gums and varnishes in which various pigments, dryers and other materials compatible with plastics are used.

Etching: The method of etching plastics is very similar to the process applied to metals, in which sections are blocked out with a suitable "resistant," after which the exposed sections are etched with a proper solvent. After etching, the background is colored, leaving the highlighted letters in the color of the plastic.

Pantographic Engraving is done by means of pantographic machines using motor-driven rotary cutters. These machines are divided into two classes, one a small portable unit used in stores for engraving names or monograms on fountain pens, pocket knives or other small articles; the other is a heavy machine used in industrial plants, shipyards, electrical and aircraft instrument plants for engraving dials, nameplates and various plastic-molded products.

Silk Screening is similar to the methods used on textiles. On plastics the process uses lacquer and oil base paints, and drying is comparatively slow.

Metal Plating and Metal Inlaying of plastic articles is finding a wide use. Plastic plated materials have the appearance of solid metals and weigh about one-half as much as aluminum. The plastic is first given an application of a highly conductive and strongly adherent bond coat made necessary by the fact that plastics are non-conductors. It is then plated with any metal that can be electrodeposited, such as copper, gold, silver, lead, zinc, cadmium and many others. Finishing operations are the same as applied to metals. This process is particularly adaptable to the manufacture of parts for electrical equipment, insignia for army and navy lapel buttons, etc.

Metal Inlays may be molded into plastics or put in after the piece is molded, the latter process being the more popular. This process finds application in electrical apparatus, radio housings, tuning devices, etc.

Machining and Equipment

Machinery and equipment used in the manufacture of plastic products are preforming presses used in forming tablets, compression presses for molding or lami-

nating, extruding and injection molding machines, preheating ovens, high frequency electric heaters, heating equipment for mold, dies, etc., accumulators or other means of producing very high pressures, air compressors, water systems for cooling molds, dies, etc., mixers, scrap grinders, mills and machine tool equipment for the manufacture of dies, mold and other parts.

Presses rate in size from small laboratory units to those developing several thousand tons pressure.

In most press operations heat as well as pressure is needed to cure the plastic material. Heat may be applied directly to the mold or through heated platens. Heat supplied by steam and electricity is most commonly used. Gas has been used, but not to any extent.

Ejection Molding and Extrusion Machines are for the most part individual self-contained units with built-in motor drives. These machines require heat, which may be supplied by steam, electricity, circulating hot water or circulating hot oil.

Preheating Ovens are used to remove moisture or to heat the plastic material to a predetermined temperature. Temperatures vary from 100° to 280° F., depending on the nature of the work.

The use of infra red lamps for preheating and drying has been developed to a great extent, using small portable units which are very flexible and economical and can be adapted to varying conditions by varying the number of lamps used.

Preheating by radio frequency is one of the newest methods and employs the use of radio frequency generators producing a high frequency current, the material to be heated being placed between two conductors. Uniform heating and speeding up of operations are the principal advantages of this process. Small units are usually employed.

Mills, Mixers and Grinders are similar to those used in the rubber and other industries.

Machine Tool Equipment is of the type usually found in tool rooms and need not be elaborated in this article.

Hazards.

The manufacture of plastic materials involves processes and materials which are hazardous and too involved for discussion in this article. The finished material is delivered by the manufacturer in the form of powder, granules, sheets, rods, etc., and is molded or otherwise fabricated into salable articles. On the whole this does not involve any very serious hazards, with the exception of the nitrocellulose products.

The following is taken from a letter recently received from one of the largest manufacturers of plastics in this country.

> Actually, it is our observation that such hazards as exist on most of the present plastics are confined largely to the material manufacturers. There is very little hazard in fabricating most of the plastics, with the possible exception of nitrocellulose. So much has been written and published on the hazard of nitrocellulose over such a long period that most of the trade know pretty well how to handle this product.

Safeguards for the storage, handling and manufacture of articles from pyroxylin plastic have been established by the N.F.P.A. Committee on Hazardous Chemicals and Explosives, in the Standards for the Storage, Handling and Use of Pyroxylin Plastic in Factories Making Articles Therefrom.

We cannot too strongly emphasize the hazardous nature of pyroxylin plastic materials. All processes involving its use should be carefully investigated and steps taken to see that these processes are safely set up.

In the fabricating of plastics other than pyroxylin, there are, however, a few special hazards which include drying of raw materials and finished products, heating of molds, platens, dies, etc., use of accumulators, flammable dyes, lint and fly in rayon plants, manufacture of plywood and other laminates, dust from finishing machines, degreasing of mold, tumbling, etc.

Dryers for raw materials, coated cloths and fabrics may be steam, electric, oil or gas heated. Volatile solvents may be present and particular attention should be given to the proper arrangement of heating units, ventilation, power and light wiring, etc. These processes together with spreading may also involve solvent recovery, which must also be given careful consideration.

Heating of Molds, platens, dies, etc., is usually done by high pressure steam, but may be done by circulating hot water or circulating hot oil. High pressure steam in many cases is furnished by small automatic gas or oil fired boilers located near the units served and not cut off. These boilers may be set up on combustible floors and should be inspected for proper installation. Circulating hot oil units may be built into the molding machine or other pieces of equipment or serve several units. This process involves the use of high flash point oil at elevated temperatures and careful consideration should be given to the arrangement of heaters, piping, etc.

Circulating hot water is finding extended use and involves the use of heaters, pumps, etc., and high pressures to obtain the high temperatures necessary. The arrangement of heaters and piping should be given consideration to be sure that they are safely installed.

High pressures are necessary at presses and involve the use of accumulators, high pressure pumps, piping, etc. The large accumulators serving several units use water as a pressure carrying medium. Smaller units usually have built in hydraulic systems using oil at high pressure. The arrangement of piping, particularly on systems using oil, should be given careful study to be sure it is safely installed.

Dyes used in coloring various types of plastics may contain volatile solvents such as butyl alcohol.

Tumbling: Plastic parts are finished in some cases by tumbling in sawdust mixed with kerosene, paraffin, flushing oils, hot wax, etc. The nature of the oil used should be considered and the safe disposal of the oil or dirty sawdust provided for.

The Fabricating of Plywood or other types of laminates involves the use of cements or adhesives containing volatile solvents, drying, woodworking, etc., and the installation of these processes should be carefully studied.

Plastic Wood is made by dissolving 25% to 30% of nitrocellulose scrap in acetone, benzol or toluol and then adding wood pulp (woodflour), castor oil, alcohol and sodium metasilicate (water glass). After mixing, the plastic wood is packed in tin cans as soon as possible because the mass solidifies rapidly when exposed to the air due to the evaporation of the solvents. The solvent vapors are flammable.

Heat Damage. Plastics, particularly those that come under the heading of thermoplastics, are susceptible to heat and may be ruined or warped in case of a fire near by which develops any great amount of heat.

Dust from grinders, saws or other types of equipment, such as elevators and finishing machines, will form explosive mixtures with air.

Cleaning grease from dies involves the use of cleaning fluids, which should be of an approved type.

Plastic Dust. The dusts of most of the plastics are explosive when in suspension in air, and special precautions are necessary for the avoidance of dust explosions wherever dust is present, either in connection with the manufacture or handling of powders produced from molding or from grinding or buffing operations. Recommended precautions include good housekeeping to prevent any unnecessary accumulations of dust, elimination of possible sources of ignition, provision for explosion venting of both buildings and equipment, special types of dust collecting systems, and other measures which have been found effective in occupancies subject to the dust explosion hazard. The hazard of plastic dusts has been studied by the N.F.P.A. Committee on Dust Explosion Hazards and on their recommendation a Code for the Prevention of Dust Explosions in the Plastics Industry was adopted by the Association in 1945. This gives detailed provisions for all common types of plastic dusts with data indicating the relative susceptibility to dust explosions on the part of dusts from the various plastics.

Fire Protection.

Fire protection for all plastics other than pyroxylin can be handled by the usual types of extinguishers, small hose and automatic sprinklers. Where flammable solvents are used, the protection provided should be suitable for flammable liquid fires. In such cases, the type of protection should be planned for the particular solvents used. Some of the solvents are miscible with water and fires in them may be effectively handled with water. Others call for carbon dioxide, foam or other special forms of protection. In any case, automatic sprinkler protection is desirable.

Pyroxylin plastics have unusual burning characteristics calling for special forms of protection. An automatic sprinkler system is necessary wherever these plastics are stored or handled in any quantity, and in the case of storage vaults the N.F.P.A. standards specify closer spacing and greater water supplies than for ordinary building protection. Owing to the possibility of the liberation of a large quantity of gas in the case of decomposition of pyroxylin, liberal vents are necessary in vaults or other confined spaces where pyroxylin plastic is stored in any quantity.

The various N.F.P.A. committees concerned with hazards and protection have studied these problems and have developed standards for protection which are published by the Association in the National Fire Codes for Extinguishing and Alarm Equipment. Detailed information on the safeguarding of the pyroxylin hazard, also the safeguarding of flammable solvents and the selection of the appropriate extinguishing agent for any individual solvent is covered in the National Fire Codes for Flammable Liquids, Gases, Chemicals and Explosives.

Acknowledgment: We are indebted to the 1944 Plastic Catalog, E. I. du Pont de Nemours Co. and various N.F.P.A. publications for a great deal of the information appearing in this article.

Fire and Heat Properties of Plastics.

[Extracted from Plastics Properties Chart of the 1945 Plastics Catalog copyrighted by the Plastics Catalogue Corp. Copies of complete chart, containing much additional information on other properties of plastics can be obtained from Industrial Magazine Service, Inc., 122 E. 42nd St., New York 17, N. Y.]

	Burning Rate	Resistance to Heat. Degrees F. (Continuous)	Distortion Point. Degrees F.
Aniline-Formaldehyde Resin			
No Filler	Very low	180-190	210-245
Casein	Very low	—	300
Celloulose Compounds			
Ethylcellulose	Slow	140-220	120-200
Cellulose Acetate			
Sheet	Slow	140-220	100-165
Molding	Slow	140-220	100-215
Cellulose Acetate, High Acetyl	Slow	150-220	120-215
Cellulose Acetate Butyrate	Slow	140-220	100-180
Cellulose Nitrate (Pyroxylin)	Very high	ca. 140	120-165
Cold Moulded—Bituminous			
Non-Refractory (Organic)	Nil	500	—
Cold Molded—Ceramic			
Refractory (Inorganic)	Nil	1300	—
Elastomeric Styrene Plastic	Slow	—	140-150
Lignin Plastic			
(Laminated)	Slow	175	—
Melamine-Formaldehyde Compound			
Alpha Cellulose Filler	Nil	210	385
Asbestos Filler	Nil	300-380	266
Methyl Methacrylate Resin			
Cast	Slow	140-160	150-255
Molding	Slow	120-160	150-230
Macerated Fabric Filler	None	230	—
Macerated Fabric Filler Phenolac Modified	Very low	230	—
Nylon Resins			
(Molding)	Self-extinguishing	—	170
Organic Polysulfide Moulding Compound	Slow	150-200	—
Phenol-Formaldehyde Compounds			
Molding			
No Filler	Very low	250	240-260
Woodflower Filler	Very low	300	260-300
Mineral Filler	Nil	250-400	240-350
Macerated Fabric Filler	Approx. nil	250	250-300
Sisal Felt Filler	Very low	250	320
Pulp Preformed	Very low	250	—
Laminated			
Paper Base	Very low	212-250	>320
Cotton Fabric Base	Very low	212-250	>320
Glass Fabric Base	Nil	480	>320
Asbestos Cloth Base	Approx. nil	250-300	>320
Wood Base	Very low	212-250	>320
Cast			
No Filler	Very low	160	113-176
Asbestos Filler	Almost nil	265	—
Casting Resin (Mechanical Grade)	Very low	250	240-260

Fire and Heat Properties of Plastics.

	Burning Rate	Resistance to Heat. Degrees F. (Continuous)	Distortion Point. Degrees F.
Phenol-Furfural Compounds			
Woodflower Filler	Very low	250	270-290
Mineral Filler	Nil	390	275-290
Fabric Filler	Nil	230	—
Polystyrene	Slow	—	140-150
Polyvinyl Alcohol	Slow	—	—
Polyvinyl Butyral Resins			
Rigid	Slow	115	118-130
Flexible Unfilled	Slow	—	—
Flexible Filled	Slow	—	—
Thermosetting	Slow	100-140	—
Polyvinyl Chloride Resins			
(Plasticized)	Nil to slow	150-175	170-250
Rubber Compounds			
Chlorinated Rubber	Nil	—	140
Modified Isomerized Rubber	Slow	—	165-220
Hard Rubber			
No Filler	Medium	—	—
Mineral Filler	Medium	—	—
Shellac Compound	High (wood filler)	150-190	—
Vinyl Chloride Acetate Resins			
Rigid	Nil	130	140-150
Flexible Filled	Dependent on type and amount of plasticizer	125	—
Flexible Unfilled		150	—
Vinylidene Chloride Resins			
(Molding)	None	160-200	150-180
Urea-Formaldehyde Compound			
Alpha Cellulose Filler	Very low	170	260-280
Vulcanized Fibre			
(In general low thicknesses give high values)	Slow	350	—

Plastic Manufacturers' and Trade Names.

The following is a partial list of principal trade names. A more complete list appears in the Plastics Catalog Directory.

Trade Name	Manufacturer	Class of Plastic
Ace	American Hard Rubber Co., New York, N. Y.	Hard Rubber
Aico	American Insulator Co., New Freedom, Pa.	Cold Molded — Bituminous Type (non-refractory)
Aico-5	"	Cold Molded — Ceramic Type (refractory)
Alphide	Standard Plastics Corp., Jersey City, N. J.	Cold Molded — Ceramic Type (refractory)
Amerine	Amer. Insulator Co., New Freedom, Pa.	Cold Molded — Bituminous Type (non-fractory)
Ameroid	American Plastics, New York, N. Y.	Casein
Aqualite	Nat. Vulcanized Fibre Co., Wilmington, Del.	Phenol-Formaldehyde Laminated
Bakelite	Bakelite Corp., New York, N. Y.	Phenol-Formaldehyde Molding Phenol-Formaldehyde Cast (no filler) Urea-Formaldehyde Polystyrene Cellulose Acetate
Baker Resin	Baker Oil Tools, Inc., Los Angeles, Calif.	Phenol-Formaldehyde Cast (no filler)
Beetle	American Cyanamid Corp., New York, N. Y.	Urea-Formaldehyde
Benalite	Masonite Corp., Laurel, Miss.	Lignin
Butacite	E. I. du Pont de Nemours & Co., Inc., Arlington, N. J.	Vinyl Butyral Resin
Butvar	Shawingan Products Corp., New York, N. Y.	Vinyl Butyral Resin
Catalin	Catalin Corp., New York, N. Y.	Phenol-Formaldehyde Cast (no filler) Melamine-Formaldehyde
Celoron	Continental-Diamond Fibre Co., Newark, Del.	Phenol-Formaldehyde Laminated
Celluloid	Celanese Celluloid Corp., New York, N. Y.	Cellulose Nitrate
Cetec	General Electric Co., Pittsfield, Mass.	Cold Molded—Bituminous (non-refractory) Cold Molded — Ceramic (refractory)
Chemaco	Chemaco Corp., Berkeley Hts., N. J.	Cellulose Acetate
Cibanite	Ciba Products Corp., New York, N. Y.	Aniline-Formaldehyde Resin
Coltstone	Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.	Cold Molded — Ceramic (refractory)
Complac	Poinsettia, Inc., Pitman, N. J.	Shellac Compound
Compo-Site	Compo-Site, Inc., Newark, N. J.	Shellac Compound
Co-ro-lite (Sisal)	Columbian Rope Co., Auburn, N. Y.	Phenol-Formaldehyde Molding
Diamond Fibre	Continental-Diamond Fibre Co., Newark, Del.	Vulcanized Fiber
Dilectene	"	Aniline-Formaldehyde Resin
Dilecto	"	Phenol-Formaldehyde Laminated
Duraloy	Detroit Paper Products Corp., Detroit, Mich.	Phenol-Formaldehyde Laminated
Durez	Durez Plastics & Chem., Inc., No. Tonawanda, N. Y.	Phenol-Formaldehyde Molding
Durite	Durite Plastics, Philadelphia, Pa.	Phenol-Formaldehyde Molding

Plastics Manufacturers and Trade Names.

Trade Name	Manufacturer	Class of Plastic
Ebrok	Richardson Co., Chicago, Ill.	Cold Molded — Bituminous Type (non-refractory)
Ethocel	Dow Chemical Co., Midland, Mich.	Ethylcellulose
Farlite	Farley & Loetscher Mfg. Co., Dubuque, Iowa.	Phenol-Formaldehyde Laminated
Fibestos	Monsanto Chem. Co., Springfield, Mass.	Cellulose Acetate
Formica	Formica Insulation Co., Cincinnati, Ohio.	Phenol-Formaldehyde Laminated
Galorn	Geo. Morrell Corp., Muskegon Hts., Mich.	Casein
Gemstone	A. Knoedler Co., Lancaster, Pa.	Phenol-Formaldehyde Cast (no filler)
Gummon	Garfield Mfg. Co., Garfield, N. J.	Cold Molded — Bituminous Type (non-refractory)
Haveg	Haveg Corp., Newark, Del.	Phenol - Formaldehyde Cast (asbestos filler)
Harvite	Siemon Co., Bridgeport, Conn.	Shellac Compound
Hermit	Garfield Mfg. Co., Garfield, N. J.	Cold Molded — Ceramic Type (refractory)
Hercules E.C.	Hercules Powder Co., Wilmington, Del.	Ethylcellulose
Herculoid	"	Cellulose Acetate
Hercules C.N.	"	Cellulose Nitrate
Heresite	Heresite & Chem. Co., Manitowoc, Wis.	Phenol-Formaldehyde Molding
Indur	Reilly Tar & Chem. Co., New York.	Phenol-Formaldehyde Molding
Insurok	Richardson Co., Chicago, Ill.	Phenol-Formaldehyde Molding Phenol-Formaldehyde Laminated
Koron	B. F. Goodrich Co., Akron, Ohio.	Vinyl Chloride Resins
Koroseal	"	Vinyl Chloride Resins
Kys-ite	Keyes Fibre Co., Waterville, Me.	Phenol-Formaldehyde Molding
Lacanite	Cons. Molded Products Corp., Scranton, Pa.	Shellac Compound
Lamicoid	Mica Insulator Co., New York, N. Y.	Phenol-Formaldehyde Laminated
Lignolite	Marathon Chem. Co., Rothschild, Wis.	Lignin
Loalin	Catalin Corp., New York, N. Y.	Polystyrene
Lucite	E. I. du Pont de Nemours & Co., Inc.	Methyl Methacrylate
Lumarith	Celanese Celluloid Corp., New York, N. Y.	Cellulose Acetate
Lustron	Monsanto Chem. Co., Springfield, Mass.	Polystyrene
Luzerne	Luzerne Rubber Co., Trenton, N. J.	Hard Rubber
Makalot	Makalot Corp., Boston, Mass.	Phenol-Formaldehyde Molding
Marblette	Marblette Corp., Long Island City, N. Y.	Phenol-Formaldehyde Cast (no filler)
Marbon	Marbo Products Corp., Chicago, Ill.	Chlorinated Rubber
Melmac	American Cyanamid Corp., New York, N. Y.	Melamine-Formaldehyde
Micarta	Westinghouse Electric Co., Trafford, Pa.	Phenol-Formaldehyde Laminated
Mills Plastic	Elmer E. Mills Corp., Chicago, Ill.	Vinyldine Chlorine Resin
National	Nat. Vulcanized Fibre, Wilmington, Del.	Vulcanized Fiber
Neillite	Watertown Mfg. Co., Watertown, Conn.	Phenol-Formaldehyde Molding
Nitron	Monsanto Chem. Co., Springfield, Mass.	Cellulose Nitrate

Plastics Manufacturers and Trade Names.

Trade Name	Manufacturer	Class of Plastic
Nixonite	Nixon Nitration Works, Nixon, N. J.	Cellulose Acetate
Nixonoid	"	Cellulose Nitrate
Nylon	E. I. du Pont de Nemours & Co.	Nylon Resins
Ohmoid	Wilmington Fibre Spec. Co., East Wilmington, Del.	Phenol-Formaldehyde Laminated
Okon	American Hard Rubber Co., New York, N. Y.	Cold Molded — Bituminous Type (non-refractory)
Opalon	Monsanto Chem. Co., Springfield, Mass.	Phenol-Formaldehyde Cast (no filler)
Panelyte	Panelyte Corp., New York, N. Y.	Phenol-Formaldehyde Laminated
Parlon	Hercules Powder Co., Wilmington, Del.	Chlorinated Rubber
Phenolite	Nat. Vulcanized Fibre Co., Wilmington, Del.	Phenol-Formaldehyde Laminated
Plaskon	Plaskon Co., Inc., Toledo, Ohio.	Urea-Formaldehyde and Malamine-Formaldehyde
Plastacele	E. I. du Pont de Nemours & Co., Inc.	Cellulose Acetate
Plioform	Goodyear Tire & Rubber Co., Akron, Ohio.	Modified Isomerized Rubber
Pliolite	"	Modified Isomerized Rubber
Pregwood	Formica Insulation Co., Cincinnati, Ohio.	Phenol-Formaldehyde Laminated
PVA	E. I. du Pont de Nemours & Co., Inc.	Vinyl Alcohol Resin
Pyralin	"	Cellulose Nitrate
Plexiglas	Rohm & Haas Co., Philadelphia, Pa.	Methyl Methacrylate
Resinox	Monsanto Chem. Co., Springfield, Mass.	Phenol-Formaldehyde Molding
Resistoflex	Resistoflex Corp., Belleville, N. J.	Vinyl Alcohol Resin
Rub-tex	Richardson Co., Chicago, Ill.	Hard Rubber
Saflex	Monsanto Chem. Co., Springfield, Mass.	Vinyl Butyral Resin
Saflex TS	"	Vinyl Butyral Resin
Saran	Dow Chem. Co., Midland Mich,	Vinylidene Chloride Resins
Spauldite	Spaulding Fibre Co., Tonawanda, N. Y.	Phenol-Formaldehyde Laminated
Styron	Dow Chemical Co., Midland, Mich.	Polystyrene
Synthane	Synthane Corp., Oaks, Pa.	Phenol-Formaldehyde Laminated
Taylor	Taylor Fibre Co., Norristown, Pa.	Phenol-Formaldehyde Laminated
Tenite I	Tenn. Eastman Corp., Trenton, N. J.	Cellulose Acetate
Tenite II	"	Cellulose Acetate Butyrate
Textolite	General Electric Co., Springfield, Mass.	Phenol-Formaldehyde Molding
Thermoplax	Cutler-Hammer, Inc., Milwaukee, Wis.	Cold Molded — Ceramic Type (refractory) Cold Molded — Bituminous Type (non-refractory)
Thiokol	Thiokol Corp.	Organic Polysulfides
Ucinite	United-Carr Fastener, Cambridge, Mass.	Phenol-Formaldehyde Laminated
Uformite	Resinous Prod. & Chem. Co., Philadelphia, Pa.	Urea-Formaldehyde
Vec	Pierce Plastics, Inc., Bay City, Mich.	Vinylidine Chloride Resins
Velon	Firestone Rubber & Latex Co., Fall River, Mass.	Vinylidine Chloride Resins
Vinylite	Carbide & Carbon Chem. Corp., New York, N. Y.	Vinyl Chloride Acetate Resins
Vinylite	"	Vinyl Chloride Resins
Vinylite X	"	Vinyl Butyral Resins
Vulcoid	Continental Diamond Fibre, Newark, Del.	Vulcanized Fiber

Fires and Fire Losses Classified, 1944.

The data upon which these tables are based were obtained from ten state fire marshals' or insurance commissioners' reports for the year 1944 or the closest fiscal year thereto. Reports of these particular states were chosen because they contained the most complete classifications as to both cause and occupancy data. While the methods of reporting and tabulating fire loss figures differ from state to state, the volume of statistics from the ten typical states, representing all sections of the country, and representing both predominantly agricultural and industrial states, is sufficiently large to indicate the relative distribution of fires and fire losses.

About fifteen other states have also contributed fire loss data that have been helpful in preparing these estimates, although not in sufficient detail to permit inclusion in the tables. Fire loss information for these additional states is included as a supplement to Table V.

Tables I to IV are tabulations made from fire marshals' reports. Table I shows the number of fires in ten states, and Table II shows the fire loss by occupancies reported for the year 1944 in these states. Tables III and IV show the number of fires and losses distributed according to causes. The general classes making up both the occupancy and cause classifications were carefully chosen with regard to good practice and to classes most commonly used in the reports. Tables V to VII are recapitulations and estimates for the entire United States based upon the first four tables and adding a certain percentage to cover unreported fires and losses as explained below. In a few instances adjustments had to be made to the national estimates to prevent distortion ot any one occupancy by one unusually serious fire in a given class. If such losses had been projected on a national basis the losses would be exaggerated. Accordingly, such large losses were included only at face value when computing the national fire loss estimates.

Table V is a recapitulation of the state totals presented in the tables, with columns added to show the number of fires per thousand population and the fire loss per capita. It will be observed that a total of 44,542 fires were reported in 1944 for the group of ten states having a total population of 24,226,832 in the 1940 census. A study of the best experience available indicates that this number of fires is approximately half of the actual number of fires for the year. A number of states do not attempt to record fire where the loss is less than $25 or $50, as the case may be. To obtain an estimate of the number of fires in the United States during 1944, 100 per cent has been added to the figures derived from the ten states. When the resulting figure is applied to the whole country at the population ratio, the estimated number of fires in 1944 is 600,000, as compared with the estimate of 668,000 for 1944. This makes 4.58 fires per thousand population, as compared with 5.08 in 1943. (October, 1944, QUARTERLY, page 119.)

The estimated fire loss of $456,000,000 in the United States in 1944 was obtained by applying the population ratio to the total loss in the ten states and adding 30 per cent to cover unreported losses. Some adjustment was then made to eliminate any distortion of the estimate by one or two unusual fires as explained above and

Table I. Number of Fires by Occupancies in Ten States — 1944.

Occupancy	Illinois	Iowa	Kansas	Louisiana	Massachusetts	Nebraska	Oregon[1]	South Dakota[2]	Vermont	West Virginia	Total
I. Public Buildings											
Government buildings	5	....	....	....	29	2	13	....	....	5	54
Hospitals, institutions	10	2	7*a*	12*a*	29	2	....	2	....	....	64
Schools and colleges	50	13	13	24	43	6	27	3	8	6	193
Churches	51	17	8	18	33	11	24	1	5	3	171
Theatres, including motion pictures	36	16	11	22	12	11	40	....	5	3	156
Amusements, halls	39	9	....	....	79	1	....	12*k*	6	3	149
II. Dwelling Occupancies											
Hotels, boarding houses	179	33	15*b*	130*b*	295	23	353	26*l*	11	6	1,071
Apartments, rooming houses	2,092	128	....	....	....	83	....	11	2	20	2,336
Dwellings	4,920	1,725	1,047*c*	1,652	5,640*g*	717	5,858*g*	392	781	302	23,034
III. Mercantile											
Office buildings, including banks	142	32	206	120	78	17	....	5	2	5	607
Restaurants, taverns	325	88	....	....	143	45*b*	96	....	5	9	711
Miscellaneous mercantiles	1,149	170	....	244	560	116	489*h*	4	2	59	2,893
Warehouses	108	79	....	29	159	40	27*i*	57*g*	6	13	518
IV. Manufacturing											
Metal workers	30	4	1	5	43	....	58	8	5	....	154
Woodworkers	13	....	165	15	121	....	....	....	15	....	329
Flour mills, elevators	61	45	9	11	....	9	61	9	1	3	209
Packing plants	16	15	....	....	....	1	9	1	1	....	43
Bakeries	26	8	....	....	16	....	21	....	....	1	72
Laundries	52	11	12*d*	27*d*	26	2	35*d*	3	....	2	170
Cleaners, tailors	46	13	....	....	22	5	....	8	4	5	103
Miscellaneous manufacturing	405	47	9	92	425	34	88	5	122	21	1,248
V. Miscellaneous											
Barns	378	152	....	....	190	112	294*c*	112	1	11	1,250
Outbuildings	892	179	235	....	160	97	....	2	1	9	1,575
Lumber and coal yards	22	....	8	25	36	19	136*j*	2	....	10	258
Railroad, wharf property	29	24	11*e*	18*e*	22	12	....	7	....	....	123
Bulk oil storage, refineries	27	25	29	45	....	5	9	3	....	....	143
Garages, filling stations	1,201	171	19*f*	17*f*	306	131	32	68	25	29	1,999
Power plants, pump houses	16	4	....	....	5	1	24	2	4	1	57
Creameries and dairies	....	9	....	....	....	4	16	8	2	....	39
Miscellaneous structures	358	117	....	28	136	2	49	5	6	17	718
Motor vehicles	1,290	381	220	108	967	136	342	100	....	28	3.572
Fires other than buildings	220	91	20	110	21	43	....	20	....	6	531
Hangars and contents	....	....	....	....	1	1	....	....	2	....	4
Total	14,188	3,608	2,045*	2,752	9,597	1,688	8,201	876	1,022	577	44,554

*Duplicate 139 fires—total number 1906.
[1]Number of insurance claims, not number of fires.
[2]Fiscal year ending June 30, 1945.
[3]Does not include fires with damage less than fifty dollars.
a. Includes government buildings.
b. Includes amusements, halls.
c. Includes outbuildings.
d. Includes cleaners, tailors.
e. Includes power plants, pump houses.
f. Includes hangars and contents.
g. Includes miscellaneous mercantiles.
h. Includes office buildings and banks.
i. Includes railroad, wharf property.
j. Includes woodworkers.
k. Includes theatres and motion pictures.
l. Includes restaurants and taverns.

[1]Does not include Chicago losses.
[2]Insurance losses only.
[3]Fiscal year ending June 30, 1945.
[4]Does not include fires with damage less than fifty dollars.
a. Includes government buildings.
b. Includes amusements, halls.
c. Includes outbuildings.
d. Includes cleaners, tailors.
e. Includes power plants, pump houses.
f. Includes hangars and contents.
g. Includes miscellaneous mercantiles.
h. Includes office buildings and banks.
i. Includes railroad, wharf property.
j. Includes woodworkers.
k. Includes theatres and motion pictures.
l. Includes restaurants and taverns.

Table II. Fire Losses by Occupancies in Ten States — 1944.

Occupancy	Illinois[1]	Iowa	Kansas	Louisiana	Massachusetts	Nebraska	Oregon[2]	South Dakota[3]	Vermont	West Virginia[4]	Total
I. PUBLIC BUILDINGS											
Government buildings	$640	....	....	....	$42,416	$730	$2,037	....	....	$50,850	$96,673
Hospitals, institutions	646	$140	$14,125*a*	$28,061	40,236	7,449	....	$97	....	....	90,754
Schools and colleges	64,425	36,520	65,905	49,630	279,475	5,475	147,649	1,435	$53,361	74,500	779,375
Churches	179,558	144,771	5,536	78,509	211,749	41,668	15,679	20	9,333	22,600	709,423
Theatres, including motion pictures	84,308	106,318	16,392	112,727	17,389	43,555	21,556	....	27,958	14,570	444,773
Amusements, halls	101,134	11,050	....	....	102,289	100	....	6,777*k*	12,428	3,050	236,828
II. DWELLING OCCUPANCIES											
Hotels, boarding houses	85,428	9,196	8,316*b*	119,969*b*	362,331	13,971	122,117	29,367*l*	26,724	3,982	781,401
Apartments, rooming houses	173,259	82,015	....	....	....	28,167	....	1,882	406	42,876	328,605
Dwellings	2,897,139	970,205	280,312*c*	1,312,049	5,379,467*g*	451,221	1,808,393*g*	160,277	966,275	480,030	14,710,368
III. MERCANTILE											
Office buildings, including banks	185,821	27,406	290,553	302,832	545,002	46,279	....	237	1,230	17,015	1,416,375
Restaurants, taverns	340,743	80,418	....	....	238,764	189,295*b*	51,654	....	1,995	17,810	920,679
Miscellaneous mercantiles	1,031,823	316,979	....	709,443	1,618,423	244,961	653,247*h*	18,170	45,390	929,819	5,568,255
Warehouses	193,458	248,213	....	285,820	810,657	366,879	42,871*i*	284,925*g*	132,161	215,910	2,580,894
IV. MANUFACTURING											
Metal workers	4,852	2,334	5	1,440	148,435	....	2,847,172	5,235	12,690	....	3,022,163
Woodworkers	88,680	....	413,998	13,877	90,024	....	....	....	56,972	....	663,551
Flour mills, elevators	859,907	620,487	116,046	29,525	....	174,639	598,656	96,416	19,242	68,700	2,583,618
Packing plants	2,545	2,533	....	....	....	50	34,717	100	395	....	40,340
Bakeries	10,458	16,898	....	....	18,972	....	30,861	....	....	20,000	97,189
Laundries	91,971	14,672	2,701*d*	24,978*d*	78,208	2,379	19,504*d*	490	....	550	235,453
Cleaners, tailors	7,008	7,548	....	....	103,098	4,782	....	16,838	2,787	25,325	167,386
Miscellaneous manufacturing	1,206,684	470,168	96,898	306,816	3,017,707	113,992	1,366,452	2,938	413,188	686,513	7,681,356
V. MISCELLANEOUS											
Barns	953,359	360,186	....	....	380,487	95,649	361,482*c*	91,334	300	39,810	2,282,607
Outbuildings	271,591	143,560	308,891	....	41,116	29,099	....	1,800	7,100	64,300	867,457
Lumber and coal yards	288,495	....	42,354	220,094	179,959	33,481	1,073,657*j*	246	....	257,435	2,095,721
Railroad, wharf property	56,151	10,407	35,735*e*	53,887*e*	176,460	11,367	....	29,670	....	....	373,706
Bulk oil storage, refineries	183,683	12,652	131,835	394,810	....	7,205	27,217	4,100	....	....	761,504
Garages, filling stations	513,054	269,630	19,399*f*	40,742*f*	205,135	61,982	60,005	24,814	53,448	139,655	1,387,864
Power plants, pump houses	52,610	28,925	....	....	5,348	250	19,700	1,890	3,051	2,200	113,974
Creameries and dairies	....	16,100	....	....	....	8,000	43,595	4,780	1,571	....	74,046
Miscellaneous structures	182,790	133,791	....	42,929	309,491	4,543	132,014	345	11,171	196,179	1,013,253
Motor vehicles	141,039	76,067	36,039	39,938	136,819	38,390	66,230	24,066	....	19,535	578,123
Fires other than buildings	170,499	15,628	28,261	272,758	55,890	24,570	....	2,781	....	36,400	606,787
Hangars and contents	....	....	....	....	1,100	36,719	....	....	6,250	....	44,069
Total	$10,423,760	$4,234,817	$1,913,321	$4,445,834	$14,596,747	$2,087,556	$9,546,465	$811,030	1,865,426	$3,429,614	$53,354,570

Table III. Number of Fires by Causes in Ten States — 1944.

Causes	Illinois	Iowa	Kansas	Louisiana	Massachusetts	Nebraska	Oregon[1]	South Dakota[2]	Vermont	West Virginia[2]	Total
Chimneys, flues—defective or overheated	892	220	110*a*	88	614	42	600	64	133	27	2,790
Sparks on roofs	967	573	169	28	....	....	756	....	13	....	2,506
Defective or overheated heating equipment	1,067	305	....	320	290	130	886	60	81	37	3,176
Rubbish	1,526	17	23	179	....	71	30	38	15	6	1,905
Combustibles near heaters	123	19	14	33	236	....	....	....	4	....	429
Open lights, flames, sparks	240	18	37	31	627	157	118	84	5	11	1,328
Hot ashes, coals	238	54	118	40	151	35	408	12	26	7	1,089
Oil burners	....	23	....	....	858	....	....	22	....	....	903
Smoking and matches	2,380	411	264	383	2,908	257	1,912	91	108	32	8,746
Children and matches	....	138	....	....	545	....	....	42	....	....	725
Electrical, fixed services; fires due to misuse, or faulty wiring and equipment	1,981	440	233	203	923	204*c*	513	79	82	50	4,708
Electrical power consuming appliances	121	51	16	73	455	....	229	19	4	13	981
Flammable liquids, misc., including home dry cleaning and starting fires with	881	41	80	52	344	77	144	8	110	22	1,759
Torches, welding, cutting, plumbers, etc.	....	21	....	....	61	17	....	6	....	....	105
Lamps. lanterns, and stoves	....	63	243	....	....	28	....	118	....	21	473
Gas and appliances	96	86	33	66	14	....	....	13	1	9	318
Grease, tar, etc.	157	36	57	46	161	....	522*d*	....	10	9	998
Spontaneous ignition	451	98	25	25	439	80	91	22	14	23	1,268
Fireworks	2	2	....	....	....	....	....	....	....	....	4
Lightning	243	112	56	166	165	45	28	24	61	5	905
Thawing pipes	....	6	17	....	24	....	....	....	....	2	49
Sparks from machinery, friction	30	35	....	51	17	16	46	18	15	....	228
Incendiary, suspicious	41	19	4	13	189	8	14	3	2	15	308
Miscellaneous	358	280	61	....	8	87	32	47	3	18	894
Unknown	1,607	409	391	638	521	188	1,418	74	248	168	5,662
Explosions	128	7	26	25	37	8	105*e*	22	2	21	381
Exposure	659	124	68	292	273*b*	236	349	10	85	81	1,904
Total	14,188	3,608	2,045*	2,752	9,587	1,686	8,201	876	1,022	577	44,542

*Duplicate 139 fires—total number 1906.
[1]Includes insurance loss.
[2]Fiscal year ending June 30, 1945.
[3]Does not include fires with damage less than fifty dollars.
a. Includes defective or overheated heating equipment.
b. Exposures not included in grand total.
c. Includes electrical power consuming appliances.
d. Includes other hot metals.
e. Includes open lights, flames, sparks.

Table IV. Fire Losses by Causes in Ten States — 1944.

Causes	Illinois[1]	Iowa	Kansas	Louisiana	Massachusetts	Nebraska	Oregon[2]	South Dakota[3]	Vermont	West Virginia[4]	Total
Chimneys, flues—defective or overheated	$439,067	$213,185	$67,962*a*	$89,508	$534,423	$30,225	$257,039	$42,947	$88,325	$48,346	$1,811,027
Sparks on roofs	301,870	192,289	43,768	52,056	....	....	413,541	....	8,499	....	1,012,023
Defective or overheated heating equipment	632,556	327,757	....	276,846	460,510	143,913	285,859	29,923	66,483	45,255	2,269,102
Rubbish	138,677	3,827	9,020	341,993	....	29,938	11,843	19,903	18,928	48,000	622,129
Combustibles near heaters	262,762	5,861	2,729	27,896	209,710	....	....	....	3,972	....	512,930
Open lights, flames, sparks	59,583	15,934	4,938	23,245	592,593	69,196	246,670	15,466	1,625	11,218	1,040,468
Hot ashes, coals	90,134	27,244	44,364	18,684	164,879	25,290	66,299	1,734	19,906	9,573	468,107
Oil burners	....	44,644	....	....	859,947	....	....	4,699	....	....	909,290
Smoking and matches	274,314	155,774	96,895	408,627	4,018,876	159,716	285,792	26,941	76,778	39,839	5,543,552
Children and matches	....	37,039	....	....	385,280	....	....	14,057	....	....	436,376
Electrical, fixed services; fires due to misuse, or faulty wiring and equipment	838,910	306,185	177,297	236,983	1,847,749	238,426*c*	312,526	25,046	240,605	109,934	4,333,661
Electrical power consuming appliances	50,908	28,033	3,117	45,980	96,546	....	880,914*d*	16,753	405	90,340	1,212,996
Flammable liquids, misc., including home dry cleaning and starting fires with	648,840	26,648	69,968	14,803	317,310	136,178	84,149	8,477	78,836	137,936	1,523,145
Torches, welding, cutting, plumbers, etc.	....	231,844	....	....	297,348	12,428	....	3,055	....	....	544,675
Lamps. lanterns, and stoves	618,456	48,407	100,166	....	....	31,405	....	84,538	....	125,100	389,616
Gas and appliances	50,295	10,334	21,675	74,345	17,742	....	....	2,034	250	9,990	186,665
Grease, tar, etc.	47,987	13,118	13,997	36,315	160,270	....	394,100	....	1,136	3,973	670,896
Spontaneous ignition	484,748	484,041	23,674	43,150	894,993	112,766	146,133	176,763	25,988	485	2,392,741
Fireworks	....	296	....	....	....	....	....	....	....	....	296
Lightning	422,923	317,419	77,796	94,285	227,981	44,190	5,868	79,724	64,430	8,750	1,343,366
Thawing pipes	....	5,525	....	....	25,782	....	....	....	....	270	31,577
Sparks from machinery, friction	112,868	24,568	23,906	46,925	34,926	5,824	115,674	9,915	53,078	....	427,684
Incendiary, suspicious	19,662	7,425	935	14,436	416,612	12,580	45,286	145	4,650	100,553	622,284
Miscellaneous	271,421	203,884	49,875	....	10,937	22,852	23,449	16,452	4,602	8,245	611,717
Unknown	4,469,202	1,339,969	863,346	1,902,758	2,976,026	824,236	5,595,597	206,360	821,082	2,077,980	21,076,556
Explosions	51,112	43,966	152,825	361,033	48,634	4,481	61,975*e*	14,738	659	181,872	921,295
Exposure	755,921	119,601	65,068	335,966	552,296*b*	183,851	313,751	11,360	285,189	371,955	2,442,662
Total	$10,423,760	$4,234,817	$1,913,321	$4,445,834	$14,599,074	$2,087,495	$9,546,465	$811,030	$1,865,426	$3,429,614	$53,356,836

[1]Does not include Chicago losses.
[2]Includes insurance loss.
[3]Fiscal year ending June 30, 1945.
[4]Does not include fires with damage less than fifty dollars.
a. Includes defective or overheated heating equipment.
b. Exposures not included in grand total.
c. Includes electrical power consuming appliances.
d. Includes other hot metals.
e. Includes open lights, flames, sparks.

to include certain fire losses not represented in the state loss figures, such as large losses in U. S. government properties. This estimate is $53,000,000, or 13.2 per cent above the estimate for 1943. The 1944 fire loss estimated by the National Board of Fire Underwriters was $437,273,000. Their figures are based upon losses reported by member insurance companies reporting to the Board with 30 per cent added to cover unreported and uninsured losses. However, it is recognized that during wartime there are many serious fire losses in uninsured government properties that are not included in the National Board insurance loss reports, so that the estimate by the N.F.P.A. Department of Fire Record is believed conservative. Fire losses increased rapidly during the war period. National Board loss estimates for the twelve months ending August 31, 1945, totaled $447,703,000.

Table V. Fires per 1000 Population and Fire Loss per Person for Ten States, 1944, as Reported by Fire Marshals.

State	Population 1940 Census	Number of Fires	Fires per 1000 Pop.	Fire Loss	Fire Loss Per Person
Illinois	7,897,241	14,188	1.79	$10,423,760(1)	$1.32
Iowa	2,538,268	3,608	1.42	4,234,817	1.67
Kansas	1,801,028	2,045(2)	1.13	1,913,321	1.11
Louisiana	2,363,890	2,752	1.17	4,445,834	1.88
Massachusetts	4,316,721	9,587	2.21	14,597,090	3.36
Nebraska	1,315,834	1,686	1.28	2,087,495	1.59
Oregon	1,089,684	8,201(3)	7.60(3)	9,546,465	8.84
South Dakota	642,961	876	1.36	811,030(4)	1.26
Vermont	359,231	1,022	2.82	1,865,426	5.19
West Virginia	1,901,974	577	3.04	3,429,614(5)	0.93
Total	24,226,832	44,542	1.84	$53,354,852	$2.20(2)
Estimated U. S. Total	131,669,275	600,000	4.58	456,000,000	3.48

(1) Chicago losses or population not included.
(2) Duplicate 139 fires — total number 1906.
(3) Includes total insurance claims.
(4) Fiscal year ending June 30, 1945.
(5) Does not include fires with damages less than fifty dollars.

States Reporting Partial Data (Not Included in Tabulations).

	Population	Number of Fires	Fire Loss	Fire Loss Per Person
Alabama	2,832,961	....	$4,229,311	$1.49
Indiana	3,427,796	5,288	8,454,223	2.47
Kentucky	2,845,627	2,757(1)	2,473,365(1)	0.87
Maryland	1,821,244	2,255(1)	2,054,310(1)	1.13
Michigan	5,256,106	51,576	19,359,537	3.68
Minnesota	2,792,300	2,227(2)	4,258,071(2)	1.52
Montana	559,456	651	596,074	0.99
North Dakota*	641,935	....	1,144,885	1.78
Ohio	6,907,612	25,500(3)	20,950,000(3)	3.03(3)
Rhode Island	713,346	1,966	1,549,818	2.16
South Carolina	1,899,804	....	3,575,842	1.84
Tennessee	2,915,841	....	4,313,720	1.48
Texas	6,414,824	....	13,831,743	2.15
Virginia	2,677,773	....	4,638,517	1.73
Wisconsin	3,137,587	16,731	4,313,720	1.38
Total for group	44,844,212	108,951	$95,743,136	$2.14

(1) Fire losses over $50 only.
(2) Fire losses over $25 only.
(3) Estimated.
*June 30, 1944, to July 1, 1945.

Table VI. Estimated Distribution of U. S. Fire Losses by Occupancies, 1944.

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states they should not be taken as exact records for each class.

Occupancy	No. of Fires	Loss
I. PUBLIC BUILDINGS		
Government buildings	1,100	$50,000,000
Hospitals, institutions	900	750,000
Schools and colleges	2,300	6,000,000
Churches	2,200	5,000,000
Theatres, including motion pictures	2,100	3,250,000
Amusements, halls	2,300	3,650,000
II. DWELLINGS		
Hotels, boarding houses	12,500	4,000,000
Apartments, rooming houses	48,000	4,500,000
Dwellings	285,000	104,000,000
III. MERCANTILE		
Office buildings, including banks	8,000	10,500,000
Restaurants, taverns	11,000	8,000,000
Miscellaneous mercantiles	40,000	45,000,000
Warehouses	6,900	24,000,000
IV. MANUFACTURING		
Metal workers	2,100	8,500,000
Woodworkers	2,900	11,750,000
Flour mills, elevators	3,100	20,000,000
Packing plants	1,100	500,000
Bakeries	1,300	1,000,000
Laundries	2,200	1,750,000
Cleaners, tailors	1,700	1,500,000
Miscellaneous manufacturing	15,500	53,000,000
V. MISCELLANEOUS		
Barns	19,500	19,300,000
Outbuildings	23,000	7,000,000
Lumber and coal yards	3,700	8,500,000
Piers, including shipyards	500	6,500,000
Railroad property	5,500	9,600,000
Bulk oil storage, refineries	2,500	5,500,000
Garages, filling stations	25,000	9,750,000
Power plants, pump houses	900	1,000,000
Creameries and dairies	2,000	500,000
Miscellaneous structures	10,000	13,500,000
Motor vehicles	45,000	4,000,000
Fires other than buildings	10,000	2,000,000
Hangars and contents	200	2,200,000
Totals	600,000	$456,000,000

NOTE: As explained in the text, 100 per cent has been added in estimating the number of fires, and 30 per cent has been added to the losses to cover unreported losses.

Railroad losses have been separated from pier, wharf property fire losses reported by State Fire Marshals. Railroad losses from Association of American Railroads report.

Table VII. Estimated Distribution of U. S. Fire Losses by Causes, 1944.

These estimated figures are intended to show the relative order of magnitude of fire losses by causes, and while they are reasonable approximations based on the experience in typical states they should not be taken as exact records for each class.

	No. of Fires	Loss
Chimneys, flues—defective or overheated	34,500	$15,400,000
Sparks on roofs	47,000	10,500,000
Defective or overheated heating equipment	60,000	15,000,000
Rubbish	23,000	6,000,000
Combustibles near heaters	7,000	10,000,000
Open lights, flames, sparks	17,000	8,000,000
Hot ashes, coals	13,000	3,250,000
Oil burners	3,500	2,000,000
Smoking and matches	100,000	43,000,000
Children and matches	29,000	1,000,000
Electrical, fixed services; fires due to misuse, or faulty wiring and equipment	58,000	43,580,000
Electric power consuming appliances	12,500	10,000,000
Flammable liquids, misc., including home dry cleaning and starting fires with	23,000	12,000,000
Torches, welding, cutting, plumbers, etc.	3,500	11,250,000
Lamps, lanterns, stoves	17,500	9,500,000
Gas and appliances	4,000	1,800,000
Grease, tar, etc.	12,500	5,500,000
Spontaneous ignition	16,000	29,000,000
Fireworks	100	20,000
Lightning	11,500	10,000,000
Thawing pipes	1,400	600,000
Sparks from machinery, friction	3,500	3,500,000
Incendiary, suspicious	3,500	10,000,000
Miscellaneous	12,000	5,100,000
Unknown	62,000	153,000,000
Explosions	4,500	20,000,000
Exposure	20,500	17,000,000
Totals	600,000	$456,000,000

NOTE: As explained in the text, 100 per cent has been added in estimating the number of fires, and 30 per cent has been added to the losses to cover unreported losses.

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Modern fire-fighting apparatus is among the most efficient equipment in the world, but it won't put out a fire unless it is operated by trained and efficient men.

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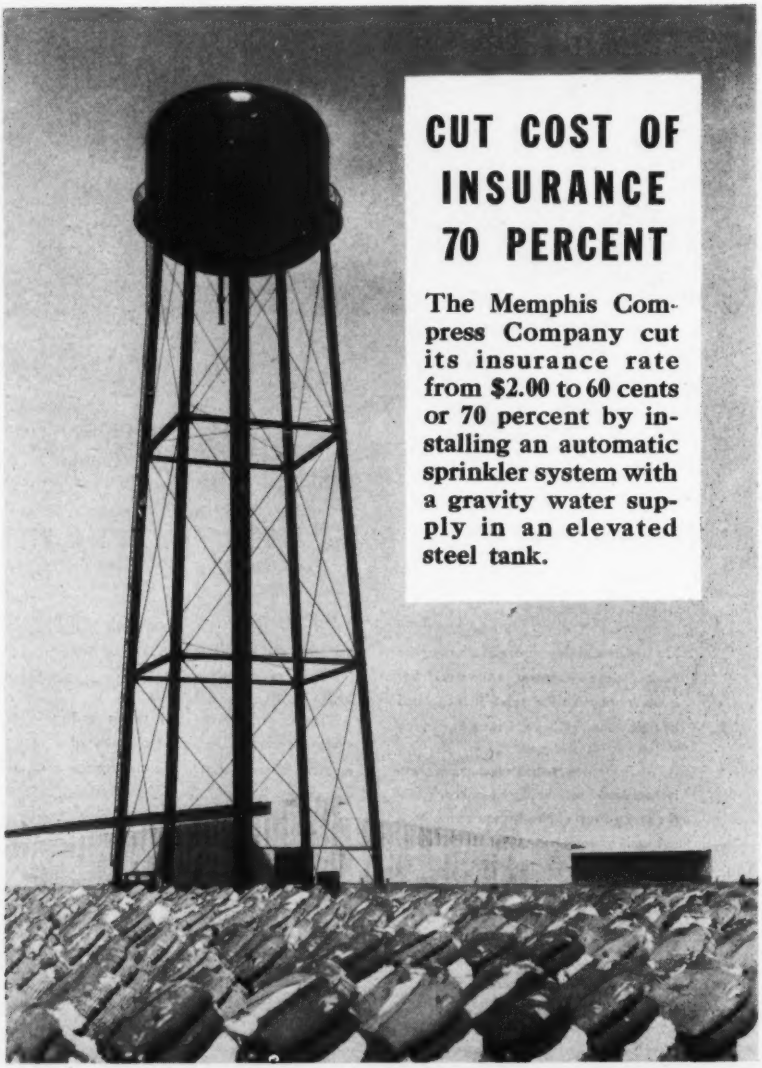
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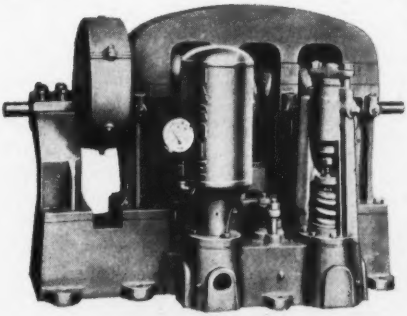

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Corrosion-Proof Sprinklers
Directional Flow Sprinklers
Open Sprinklers
Spray Sprinklers
Alarm Devices

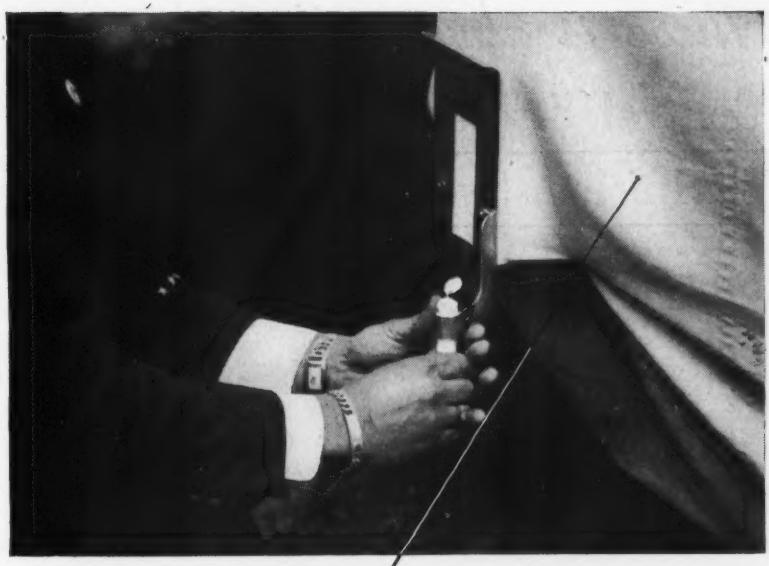
Automatic Releases
Alarm Valve (Wet) Systems
Dry Pipe Valve Systems
Deluge Systems
Heat-Actuating Devices
Pre-Action Systems

Star Automatic Sprinklers and Fire Protection Devices bear approval of all Insurance Authorities having jurisdiction and various Governmental Agencies

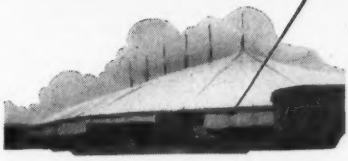
Economy in installation cost and maintenance has dictated the consistent policy of Star Sprinkler Corporation in distributing its Fire Protection Devices through local licensed contractors who have had a lifetime of experience in the installation of automatic sprinkler systems. Operating throughout the United States, Canada and South America, Star licensees, due to their strategic locations, can render instant service. Write us for name and address of Star licensed contractor nearest your location.

STAR SPRINKLER CORP.

Westmoreland and Collins Sts. - Philadelphia, Pa.



They had to be shown



The illustration above shows a close-up of the Pinkney flame test being conducted on a FIRE CHIEF Finished canvas sidewall of the Circus "Big Top" by officials of the District of Columbia Fire Department and the National Bureau of Standards.

The successful development of FIRE CHIEF Finish by Hooperwood "Canvas Engineers" has enabled manufacturers of tents, awnings, tarpaulins and canvas covers of all types to offer their customers a product that is positively fire resistant and proofed against the elements.

FIRE CHIEF Mill Finished Hooperwood Canvas will be available for civilian use as soon as canvas is released from government allocation.

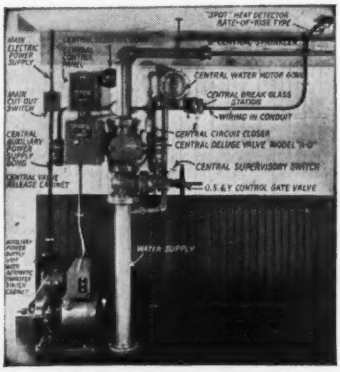
FIRE CHIEF Compound, for applying to new or used untreated canvas, is now available in limited quantities to users who can certify to the need in the interest of public safety.

WM. E. HOOPER & SONS CO.
New York PHILADELPHIA Chicago
Mills: WOODBERRY, BALTIMORE, MD.

• Fire-Chief Finished •
HOOPERWOOD COTTON DUCK

There is always the One Best

Central "Electro-Speed" Deluge Sprinkler System Model "AD"



Completely Electrically Operated

• • •

Rate of Rise and Fixed Temperature Controlled

• • •

Fully Supervised

"A PRODUCT OF THE ELECTRONIC AGE"

Over three years ago we pioneered the first Underwriters approved electrically operated deluge type automatic sprinkler system. We now present, in the CENTRAL Model "AD" Electro-Speed Sprinkler System, a completely new and all electrically operated system, amazing in its simplicity of design and in its instantaneous super-speed electric operation.

Every functional part is a standard product with years of dependable use to insure for you satisfactory and continued service.

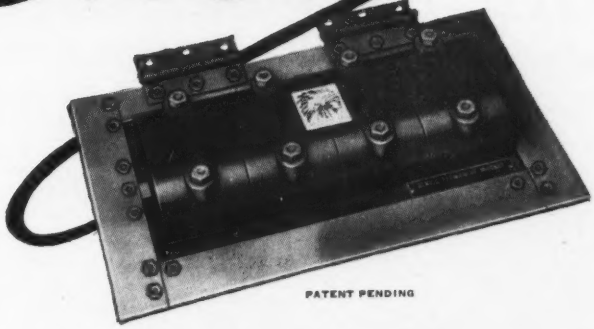
Already approximately three hundred CENTRAL Model "AD" Deluge Sprinkler Systems are now in service protecting vital United States Army and Navy, and privately owned properties, and proving their superior design and operation over older types of deluge systems in adjacent buildings in some of these properties.

Send for illustrated and descriptive bulletin N.P.-V-4.

CENTRAL AUTOMATIC SPRINKLER CO.

241 EAST ASHMEAD STREET . . PHILADELPHIA, PA.

Eriez



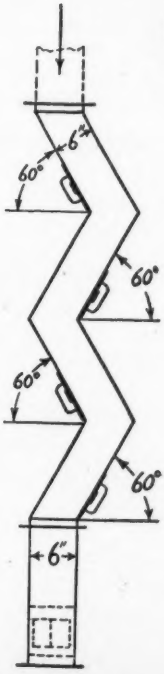
PATENT PENDING

NON-ELECTRIC PERMANENT MAGNETIC SEPARATOR

for Fire Prevention . . .

"The use and value of permanent magnets has increased in recent years, due to improvements in design of the physical magnet and composition of the metal itself. The permanent magnet has sufficient strength to give complete satisfaction when properly installed. The permanent magnet is simple, requires practically no maintenance other than cleaning of collected trash, easily understood and maintained by ordinary labor, not dependent upon outside source of power, relatively light in weight, extremely flexible in design, economic in cost and presents no additional fire hazard of its own to the process protected."

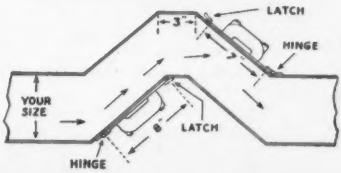
Factory Insurance Association
Hartford, Connecticut



SIDE VIEW

Above: **Typical installation in bottom of chute.**

Left: **Powder mill chute installation.**



Typical pneumatic duct installation—Note baffle effect of magnets.

ERIEZ MANUFACTURING COMPANY
39 East 12th Street · Erie, Pennsylvania

like having a

FIRE DEPARTMENT

IN YOUR OWN PLANT

INDUSTRIAL SPRINKLER SYSTEMS

Viking Sprinkler Systems go into action with the speed of a Fire Department in your own plant. In peace and war Viking Sprinkler Systems are protecting industrial plants across the nation against the universal enemy of production . . . . FIRE. There is a Viking dealer near you to give you all the facts.

VIKING CORPORATION DEALERS

Crawford & Slaten Co.
Atlanta, Georgia

C. W. Hutchinson, Inc.
Huntington, W. Va.

Indiana Automatic Sprinkler Co.
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Texas Automatic Sprinkler Co.
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Viking Automatic Sprinkler Co., San Francisco, California

THE VIKING CORPORATION
HASTINGS, MICHIGAN

Photograph of the spectacular Fiberglas draperies and decorations that help to insure fire-safety for ICELAND, Broadway's biggest restaurant. Other night spot installations include the Latin Quarter and the Bal Tabarin, in New York. (Decorations by Kaj Velden Studios.)

AN OUNCE OF PREVENTION...

Night spot operators know the customer-value of smart interiors—and how quickly a careless match can start a holocaust. That's why *Iceland* has been entirely redecorated with Fiberglas fabrics—wall coverings, ceiling, draperies and curtains—for these handsome materials CANNOT BURN. Woven of finely spun glass filaments, they never need flameproofing. If exposed to fire, will not emit choking fumes. So practical, they have been installed in school auditoriums in New York, Chicago and other cities. A limited quantity in printed designs and solid colors is now available.

WRITE FOR SAMPLES AND INFORMATION

FIBERGLAS*

Fiberglas is used in all ships of the U. S. Navy (Bureau of Ships Spec. 27 C 7). Listed by Underwriters' Laboratories, Inc., as "Noncombustible Fabric"; approved by Bureau of Standards and Appeals, City of New York.

THORTEL

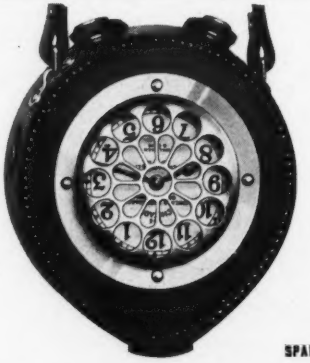
FIREPROOF FABRICS

Architects Building, 101 Park Ave., New York 17, N. Y.

LExington 2-0711

*T.M. Reg. U.S. Pat. Off. Owens-Corning Fiberglas Corp.

Protect your property! Install Chicago patrol stations at every point of hazard . . . then equip your watchmen with time tested and proven



SPARTAN

CHICAGO WATCHCLOCKS

Guarantee that these Danger Points are constantly inspected according to schedule

Thousands of Chicago Watchclock systems are daily safeguarding billions of dollars invested in the plants, mills and warehouses of industry, by compelling watchmen to be alert, vigilant and constantly on the job. . . . No "skipped" rounds, no falsified records, no dangerous "short cuts." Recommended by insurance authorities, plant executives and approved by Underwriters' Laboratories, Inc. and Associated Factory Mutuals Laboratories.

MINUTE MAN

CHICAGO

Four Models: One to fit every need for providing complete plant protection

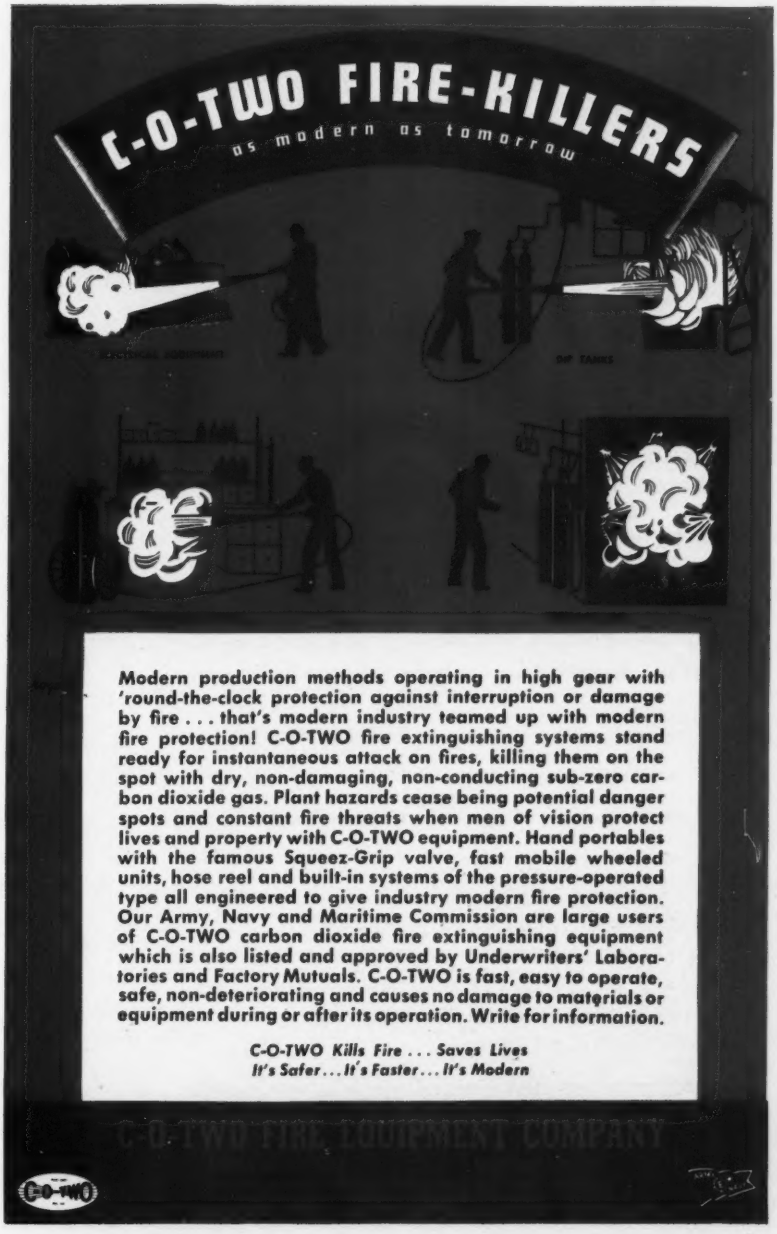
▪ ▪ ▪

Designed and built by the

LEADING MANUFACTURERS OF WATCHCLOCK SYSTEMS FOR MORE THAN SIXTY YEARS

CHICAGO WATCHCLOCK CORPORATION

Chicago • New York • Atlanta • Los Angeles


C-O-TWO FIRE-KILLERS
as modern as tomorrow
Modern production methods operating in high gear with 'round-the-clock protection against interruption or damage by fire . . . that's modern industry teamed up with modern fire protection! C-O-TWO fire extinguishing systems stand ready for instantaneous attack on fires, killing them on the spot with dry, non-damaging, non-conducting sub-zero carbon dioxide gas. Plant hazards cease being potential danger spots and constant fire threats when men of vision protect lives and property with C-O-TWO equipment. Hand portables with the famous Squeez-Grip valve, fast mobile wheeled units, hose reel and built-in systems of the pressure-operated type all engineered to give industry modern fire protection. Our Army, Navy and Maritime Commission are large users of C-O-TWO carbon dioxide fire extinguishing equipment which is also listed and approved by Underwriters' Laboratories and Factory Mutuals. C-O-TWO is fast, easy to operate, safe, non-deteriorating and causes no damage to materials or equipment during or after its operation. Write for information.
C-O-TWO Kills Fire . . . Saves Lives
It's Safer . . . It's Faster . . . It's Modern
C-O-TWO FIRE EQUIPMENT COMPANY
CO-TWO

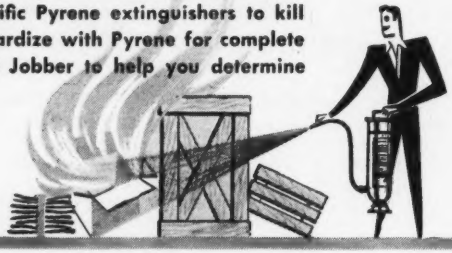
STANDARDIZE ON PYRENE

Flexibility

in fire protection to meet each hazard and risk

Too many small fires have ended disastrously because the proper extinguishing methods were not selected to protect each specific hazard. This cannot happen if your fire equipment is flexible and the proper extinguishers are ready and available to meet different fire risks. Control of fire in all of its phases has been Pyrene's business for almost 40 years. There are specific Pyrene extinguishers to kill every class of fire. Standardize with Pyrene for complete protection. Ask a Pyrene Jobber to help you determine your fire hazards.

Pyrene



For class "A" fires (fires in ordinary combustible materials—wood, textiles, rubbish, etc.) that frequently occur in warehouses, lumber yards, about farms, in homes, storage spaces or around docks, a Pyrene soda-acid, foam, water or anti-freeze type of extinguisher is recommended, and approved where cooling and quenching effect is of first importance.

BY THE WAY: WHEN DID YOU LAST TEST THE EXTINGUISHERS IN YOUR HOME?

Pyrene Manufacturing Company

NEWARK 8, NEW JERSEY

AFFILIATED WITH THE C-O-TWO FIRE EQUIPMENT CO.

This story will interest you!

A 93-foot open tank of crude oil was deliberately fired. The question to be answered was: Could Fire-Fog control and prevent the spread of fire over such a large area and still keep the tank from being destroyed?

It could and it did! By almost instant control of the burning area Fire-Fog did such an amazing job that the paint on the tank wasn't even blistered! *Fire-Fog's mist-fine water spray kept the temperatures inside the tank down to a maximum of 40 degrees in the center and 110 degrees around the outside.*

Then a second test was made—and a third—still no damage to the tank. Positive proof that Fire-Fog does protect vulnerable fire areas—definite support to the soundness of the principle of fire protection by controlled burning of flammable liquids.

Automatic in operation and super-sensitive to quick heat rises, Fire-Fog is ideal for quenching fires of flammable liquid origin. Positive protection for such areas as loading racks, process buildings and areas, flammable liquid pump houses, valve pits and the like.

"Automatic" Sprinkler

"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA

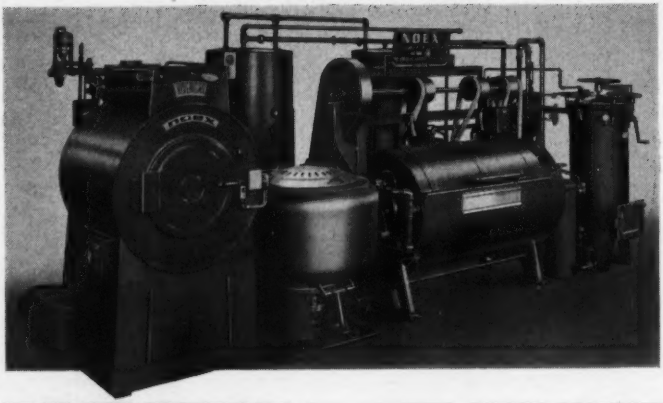
YOUNGSTOWN, OHIO ..... OFFICES IN 36 CITIES

"Automatic" Sprinkler manufactures and installs a complete line of fire protection devices and systems for all types of fire hazards. Listed by Underwriters' Laboratories, Inc., and approved by Factory Mutual Laboratories.

OK SINCE 1942

by

UNDERWRITERS' LABORATORIES



NOEX FOR POSITIVE SAFETY PROTECTION WITH 140° FLASH PETROLEUM SOLVENT

★ NOEX is designed to give *positive* safety protection with listed petroleum solvents having a flash point of 138.2° F., or over.

★ NOEX Dry Cleaning Unit has been approved by Underwriters' Laboratories as a Class II Unit *since 1942.*

★ NOEX is a quality product of the world's largest and oldest manufacturer of laundry and dry cleaning equipment.

Yours for the asking is a fully illustrated, quick-reference catalog that will give you complete information on dependably safe NOEX. It's a mighty convenient booklet to have on file. Coupon below brings it to you by return mail, free of charge.

THE AMERICAN LAUNDRY MACHINERY CO.
Ross and Section Avenues,
Cincinnati 12, Ohio.

Please send 8-page, illustrated catalog on Underwriters Approved NOEX Petroleum Solvent Cleaning Unit to:

Name.....

Address.....

City and State.....

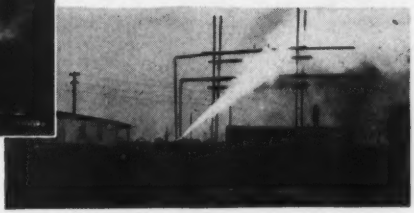
The AMERICAN LAUNDRY MACHINERY CO.

CINCINNATI 12, OHIO

BROKEN OVERHEAD GASOLINE LINE FIRE

KNOCKED OUT IN

65 SECONDS



NEW DUAL-STREAM NOZZLE

Further increases fire-fighting effectiveness of

DUGAS EXTINGUISHERS

Upper picture shows a rigorous test conducted at the DUGAS Division Test Grounds, under observation of Underwriters' Laboratories and Factory Mutual Laboratories. Burning gasoline escaped at the rate of 10 gallons per minute under 50-lb. pressure through three hack-saw cuts in a pipe 13 feet above ground.

Lower picture shows how quickly DUGAS Dry Chemical knocked out the fire after it had been allowed to burn for one full minute. Using the straight stream from the new dual-stream nozzle on a No. 350-A DUGAS Wheeled Extinguisher, the overhead gasoline fire, including blaze on ground, was extinguished in exactly 65 seconds.

NEW DUAL-STREAM NOZZLE . . .

deals effectively with spill fires and fires difficult to reach because of height or obstructions. Designed for use with DUGAS Wheeled Extinguishers, the new dual-stream nozzle greatly increases fire-fighting range and effectiveness. A turn of the handle gives a straight stream with a range of 45 feet — or a fan stream with a range of 15 feet.

Quick Facts About Dugas Dry Chemical

1—For extra-hazardous fires involving flammable gases, liquids, greases or electrical equipment.

2—Not an electrical conductor.

3—Non-toxic, non-corrosive, non-abrasive.

4—Not affected by extreme cold or heat.

Write today for complete information regarding DUGAS Wheeled Extinguishers with the New Dual-Stream Nozzle . . . and DUGAS Hand Extinguishers.

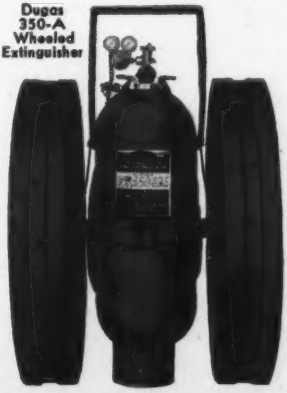
AN ANSUL PRODUCT

duGas

THE MASTER OF FLAME

Approved by Underwriters' Laboratories, and Factory Mutual Laboratories.

Dugas 350-A Wheeled Extinguisher



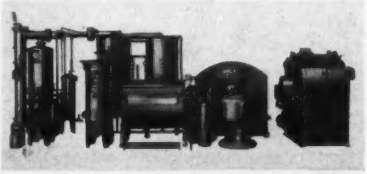
ANSUL CHEMICAL COMPANY, MARINETTE, WISCONSIN

DUGAS DIVISION

. . . TO TRY TO GET 140-F BENEFITS FROM HIGH-FLASH SOLVENT ALONE!

Fire prevention authorities and dry-cleaning experts agree; it's not high flash solvent alone—nor Underwriters Laboratories approved machinery alone—but the combination of the two—that produces complete drycleaning safety. Due to wartime shortages, some attempts have been made to use high-flash petroleum solvent in equipment lacking approved safety features. Such makeshifts are to be deplored.

Drycleaners using Hoffman 140-F drycleaning systems are able to continue their legitimate operations—using 140-F Class III machinery with listed high-flash solvents.



U. S. HOFFMAN MACHINERY CORPORATION
105 Fourth Ave., New York 3, N.Y.
DRY CLEANING LAUNDRY & GARMENT PRESSING EQUIPMENT

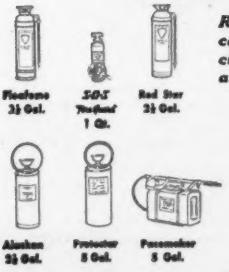
In the old days you *might* have gone to a blacksmith with a toothache. After all, he did have the pliers.

Today we ask more of a dentist. We demand that he be a specialist.

So it is with fire extinguishers. Certain types work better on certain fires. Paper and rubbish fires, for example, require an entirely different extinguisher than electrical or oil fires.

So—when you're buying fire extinguishers, buy from a firm that manufactures a complete line and can specify the *right* extinguisher for every fire hazard. Such a firm is General Detroit, specialist in "fire protectioneering" for more than 40 years.

IF IT'S GENERAL IT'S DEPENDABLE



RIGHT:* General's famous carbon dioxide extinguisher, is especially suited for fighting oil, gasoline, and electrical fires. *Write for details.

THE GENERAL DETROIT CORP.
2270 E. JEFFERSON AVE., DETROIT 7, MICH.
Distributors in principal cities
CHICAGO DALLAS NEW YORK
West Coast Affiliate: The General Pacific Corp.
Seattle • LOS ANGELES • San Francisco

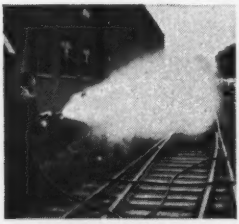
Let a General Fire Protectioneer prescribe the *right* extinguisher for your every fire hazard.

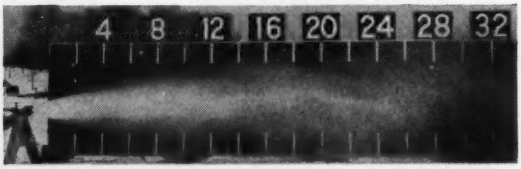
THE REAL STORY OF FMC

Don't confuse the results obtainable from FMC High-Pressure Fog Fire Fighting with any other system. There's nothing else like it for efficiency, for speed, for all-type fire protection.

These unretouched photographs show various applications of high-pressure fog as it is actually discharged from a standard FMC Fog Fire Gun. Several of the many settings are shown proving the true carrying power and steam-like fog that is usable for the speedy, efficient quenching of various types of fires. The standard capacity of one gun (two guns per unit) is 30 gallons per minute at 600 lbs. gun pressure.

All of our claims for the effectiveness of high pressure refer only to the FMC System.





WIDE FOG CLOUD. Not a hollow cone spray, but a fine dense fog with a harmless amount of entrained air at the blaze. Has an effective range of 20 to 24 feet. Imagine fighting a fire with this closely-packed fog! The fire couldn't help but cool down and smother out, and without water damage.

MIDDLE SETTING. Combination of distance, wide fog and density. Not a hollow cone! Has long range effectiveness of 30 to 40 feet. No harmful entrained air at the blaze. Very effective—reaches fire without endangering firemen. One man can handle easily. Fires can be put out without usual water damage.

LONG RANGE STREAM. Necessary only for great distance. Has reach of 50 to 60 feet. Has tremendous carrying power, penetration and effectiveness. Still is fire-fighting fog—making every gallon do maximum work. Used to reach "hard-to-get-at" fires. Uses much less water. No harmful entrained air at the blaze. One man handles gun and hose in moving around at fire.

BUILDERS OF BEAN HIGH-PRESSURE

HIGH-PRESSURE FOG FIRE FIGHTING

The Modern Way of Fighting Fire. The FMC High-Pressure Fog Fire Fighting System—originated by the John Bean Mfg. Co.—has revolutionized fire-fighting technique. ***It's the Pressure that Counts!*** In fighting fire with fog—you must have high pressure. And that's what you get with the FMC Fog Fire Fighter.

The FMC High-Pressure Pump packs the needed punch to produce and maintain *800 lbs. pump pressure*—better than *600 lbs. nozzle pressure.*

A Little Water Goes a Long Way! The high pressure gives you a combination of high velocity and finely-atomized water—just what you need to *blast—cool* and *smother* flame.

One gallon of this finely-atomized fog—properly used—has the fire-quenching possibilities of many times that of low-pressure water. Get the facts! FMC High-Pressure Fog is one of the greatest contributions ever made to fire fighting. Write today — for complete information.

★ ★ ★

STANDARD FMC FOG FIRE FIGHTER. A self-contained fire fighting unit. Carries its own water supply and complete fire-fighting equipment. Provides two guns of 30 gallons each at 600 lbs. nozzle pressure.

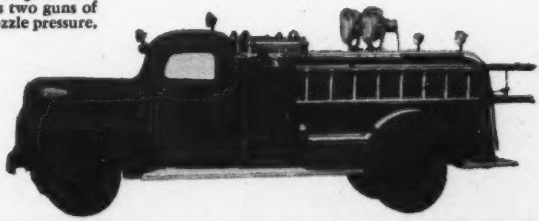
FMC FOG FIRE GUN

Built Only by Bean

The FMC Fog Fire Gun is designed especially for high-pressure work.

Note these Features:

1. **PROTECTIVE SPRAY.** Special spray protects face and shoulders from heat.
2. **ADJUSTING BARREL.** By turning barrel, flow can be changed from a straight "power" stream to a close-up fog for any type of fire.
3. **TRIGGER GRIP.** Gives natural position to arm and grip and is easy to hold.
4. **GUN LOCK.** Stream can be set in any pattern and locked there if desired.
5. **HOSE SWIVEL.** Eliminates bothersome twisting of hose.



FMC *Original* HIGH-PRESSURE FOG FIRE FIGHTER

CAN BE MOUNTED ON MOST STANDARD TRUCK CHASSIS

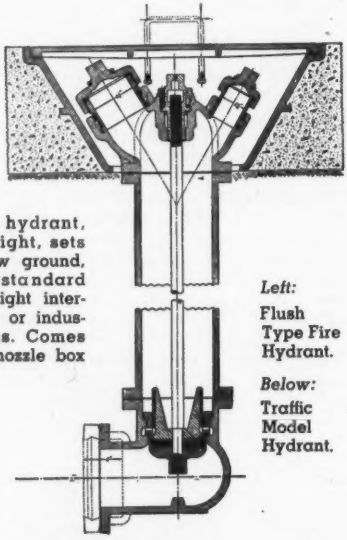
FOOD MACHINERY CORPORATION

John Bean Mfg. Co., 739 Hazel St., Lansing 4, Mich. • Bean-Cutler Division, 439 Julian St., San Jose, Calif.

PUMPS FOR OVER SIXTY YEARS

VALVES
HYDRANTS
AND PIPE LINE ACCESSORIES

M & H furnishes a complete line of AWWA Valves, iron body, bronze mounted.



Flush type fire hydrant, illustrated at right, sets completely below ground, is used where standard type hydrant might interfere with traffic or industrial operations. Comes with cast iron nozzle box and cover.

Left: Flush Type Fire Hydrant.

Below: Traffic Model Hydrant.

AWWA & UNDERWRITERS APPROVED FIRE HYDRANTS

M & H Fire Hydrants are dry top and revolving head. They are easy to lubricate. Maintenance costs are low due to simplicity of design and rugged construction. They have low friction loss and great efficiency because barrel diameter is not reduced and there are no working parts or obstruction in waterway. Special Traffic model is designed to yield at the ground line under impact. Repair is simple and easy.

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

Yes, the Kidde Water Extinguisher eliminates the fuss and bother of annual recharging. It gets its power —not from the reaction of chemicals that may deteriorate — but from a *hermetically sealed* cartridge of carbon dioxide that retains its full water-propelling efficiency for years . . . and when used does no more harm than water.

And when recharging *is* needed, after use, it's a quick, safe, simple operation. No chemicals to handle . . . no risk of acid burns. Just refill with water and slip in a replacement cartridge!

For locations where low temperatures are encountered, the Kidde Anti-Freeze Extinguisher—identical in construction with the Water Extinguisher—offers the same freedom from need of annual recharging, *plus* ability to function at temperatures as low as —40° F.

Get the facts *today* on Kidde Water Extinguishers *and* Anti-Freeze Extinguishers.

Walter Kidde & Company, Inc.
1051 Main Street, Belleville 9, New Jersey

The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Kidde

134,021 SPRINKLER ALARMS IN 1944

FIRE LOSS IMMUNITY 99 98/100 %

OVER THE PAST TEN YEARS

YEAR after year A.D.T. Sprinkler Supervisory and Waterflow Alarm Service continues to demonstrate its remarkable effectiveness in minimizing fire and water losses in thousands of sprinklered properties throughout the country.

In all types of occupancies this service is an important supplement to the protection afforded by automatic sprinkler systems. It maintains continuous, automatic watch over every vital part of the sprinkler system to assure that it is constantly in proper operating condition. It makes the sprinkler system function also as an automatic fire alarm system to summon the fire department direct to the premises—automatically—instantly—accurately.

The hard, cold facts of statistics prove the value and effectiveness of the service: During the past ten years the ratio of losses to insurable values protected has averaged 2/100ths of 1%—an immunity from fire and water loss of 99 98/100ths%.

Let us tell you how this service can be employed to effect substantial economies while providing increased protection. Write *Controlled Companies of American District Telegraph Company, 155 Sixth Avenue, New York 13, N. Y.*

CAUSES OF ALARMS RESPONDED TO DURING 1944

Waterflows (fires or serious leaks)	2,598
Closed gate valves	35,476
Low water in gravity and surge tanks	7,837
Low temperature in gravity and surge tanks	3,569
High or low air in pressure tanks	9,156
High or low water in pressure tanks	4,084
High or low air in dry pipe systems	30,329
Other alarms, usually caused by men working on sprinkler systems	40,972
TOTAL	134,021

ADT

WATCHMEN'S PATROL EFFICIENCY 99 93/100%

FIRE LOSS IMMUNITY 99 97/100 %

OVER THE PAST TEN YEARS

A.D.T. Watchman's Reporting and Manual Fire Alarm Service has a long-established, enviable record in assuring watchman efficiency by maintaining a continuous check on the watchman's patrol, investigating any failure to signal and providing him with means for obtaining immediate assistance in emergencies.

During 1944 A.D.T. Central Stations investigated 216,738 failures of watchmen to signal on schedule. This figure, however, represented only 7/100ths of 1% of the total of 329,938,615 signals recorded—a remarkable patrol efficiency of 99 93/100ths%.

The value of this service and its complementary private manual fire alarm service in providing effective fire protection is attested by the fact that during the past ten years the ratio of losses to insurable values protected has averaged 3/100ths of 1%—a fire loss immunity of 99 97/100ths%.

For complete information and illustrated booklet write *Controlled Companies of American District Telegraph Company, 155 Sixth Avenue, New York 13, N. Y.*

REASONS FOR FAILURES TO SIGNAL—YEAR 1944

Sick or otherwise disabled	2,772
Watchman missing	1,876
Forgot to signal, or overlooked time	51,940
Asleep	4,443
Intoxicated	316
Gone home	3,126
Late reporting for duty	2,616
Watching suspicious persons	472
Busy with other duties	51,345
Ordered not to turn in signal	4,856
Building locked	821
Denied failure	23,291
Refused to state reason	16,856
Access to station obstructed	4,829
Weather prevented	2,147
Watch slow or stopped	5,603
Plant in operation	15,829
Unable to locate box	4,697
Miscellaneous	18,903
TOTAL	216,738

Fire at its height when apparatus arrived

How WaterFOG Helped New Haven Fight Vicious Oil Fire

A derailed tank car . . . pulling down the high-tension wires of the electrified system . . . started a rip-roaring fire on one of the country's heaviest-traveled rail routes.

So furious was the blaze that the heavy steel towers were twisted partially from their bases and many feet of rail were warped by the intense heat. Yet a skillful attack by New Haven's fire department, under direction of Chief Paul P. Heinz, plus the use of Rockwood WaterFOG nozzles, had the fire checked in 15 minutes . . . confined to a small area in 25 minutes . . . and out in 40.

WaterFOG is used extensively by the New Haven fire department for oil, electrical and other types of fires. Adequate WaterFOG equipment and thorough training by Chief Heinz in the use of this modern method of fire fighting made possible quick extinguishment of this fire.

Rockwood WaterFOG is used by hundreds of fire departments and industrial firms to guard against fires. Rockwood-engineered applications, ranging from transformers to engine test cells, from paint shops to Hortonspheres, are approved by Underwriters' Laboratories and Associated Factory Mutuals. Write for Bulletin 123.

ROCKWOOD SPRINKLER COMPANY

56 Harlow Street, Worcester 5, Mass.

Specialists in Fire Protection Engineering, Equipment and Installation since 1907

ROCKWOOD WaterFOG

WATER, ENGINEERED BY ROCKWOOD, COOLS, CONFINES, SMOTHERS OIL FIRES

Eliminate

Delayed Alarms

Reduce

Fire Losses

YOU CAN HELP

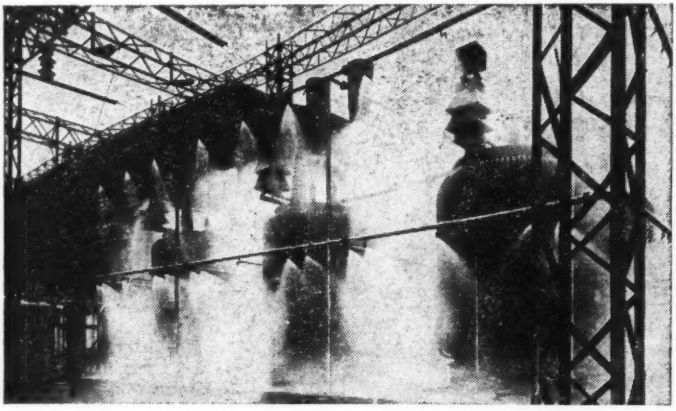
By urging the installation of a Box at Every Fire Hazard. This is essential protection.

Fire Alarm Boxes
Save Time and Protect Life, Property and Income

Write us for details

THE GAMEWELL COMPANY

Newton Upper Falls - - Massachusetts



Grinnell MULSIFYRE Systems

Grinnell MULSIFYRE Systems are designed to extinguish flammable liquid fires such as in lubricating oil lines to generators, in transformer stations for circuit breakers, in bilges of oil burning ships, etc. Mulsifyre Projectors are attached to a permanent piping system and spaced to command the area beneath. In case of fire, the Projectors discharge water with considerable force, converting the burning liquid into an emulsion which is incapable of burning. The formation of the emulsion is almost instantaneous and the fire is extinguished within a few seconds. The System may be installed to operate manually or automatically.

The Grinnell FLAMEBUSTER is a three purpose portable hose nozzle for use with water, foam or chemicals, applied as a high or low velocity spray or in a solid stream. Has many applications.

The Grinnell MULSISPRAY System is a fixed System designed for the extinguishment of fires in volatile liquids and more particularly for the protection of tanks and equipment by cooling where the exact direction and application of water is a prime requisite.

Grinnell Automatic Fire Protection Systems and Equipment are backed by over 70 years of experience. Descriptive literature will be furnished upon request.

GRINNELL COMPANY, INC.

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